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ENGINEERING:

An Illustrated Weekly Journal.

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TO FIND GRAPHICALLY THE POSITION OF UNIT LOAD GIVING ZERO STRESS IN ANY WEB MEMBER OF A GIRDER.

By JOHN EDMONDSON, B.Sc. (Leeds), Stud. Inst. C.E.

To design any member of a structure we must know the maximum stress to which that member is subjected. In calculating the greatest stress on a web member of a girder the difficulty arises as to the disposition of the load giving the maximum stress. With the English practice of using the equivalent uniformly distributed load system approximate methods have been adopted. If the concentrated load system be used, however, the question becomes more difficult.

The following graphical construction gives the position of a load causing no stress in a web member, or it is the position such that a load to the right produces tension and one to the left compression, or *vice versa*, in the member under consideration. Hence in designing the web member the greatest stress will occur when all the loads are to the left or to the right of the above position. This is true in the majority of cases; if, however, the leading wheel load is very small compared with the second one, the maximum stress may occur with the second wheel load at the position.

The accuracy of the construction has been proved for the most general type of girder, Figs. 1 and 2. The application to the more common types is shown in Figs. 3 and 4.

General Case.—Consider web member D H of girder shown in Fig. 1. To determine a position, P, so that a unit load placed at P causes no stress in member D H. The load is assumed to be transmitted to the bottom boom joints.

Graphical Construction.—(The members of the girder are indicated by thick, and the graphical construction by light, lines.)

Fig. 1: Produce C D meeting verticals through the abutments A and B in M and N respectively. At D and C erect verticals cutting member H G and H G produced in S and R. Join M R and N S and produce until they intersect at the point P. Then P is the position required. Theoretically, if a load be placed at P, the girder would not be affected by the omission of member D H.

In general the boom members chosen in the above construction will be those cut by a section which passes through the member under consideration, but does not cut any other of the web members. Thus (Fig. 1) if member C H was being designed, the members C D and K H would have been chosen.

The accuracy of the construction can be verified by finding the position P analytically, and seeing if the position so obtained agrees with the one already found graphically.

Notation.—Fig. 1*a*:—

Let R_A be vertical reaction at the left abutment A.
" W_C be portion of load carried at joint C.
" T be stress in member G H.
" B be stress in member C D.
" $\sphericalangle\alpha$ and $\sphericalangle\beta$ be the angles made by members C D and H G with vertical.
" l be length of girder.
" a be horizontal distance of joint C from abutment A.
" b " " " D " B.
" d " " between joints C and D.
" p be perpendicular distance of member G H from D.
" x be distance of required position P from the right abutment B.

To determine analytically the distance x from B, so that a load applied at P produces no stress in member D H.

Consider the equilibrium of the portion of girder cut off by the section S S (Fig 1*a*). If the algebraic sum of the resolved parts of forces R_A, T, B and W_C, in any direction be zero, then there can be no stress in member D H. For convenience we will choose the direction at right angles to bottom member C D; by choosing this direction the calculation of stress B is avoided.

Hence for zero stress in H D we have

$$T \sin(\alpha-\beta) + W_C \sin\alpha - R_A \sin\alpha = 0.$$

Considering unit load

$$R_A = \frac{x}{l};\quad W_C = \frac{x-b}{d}.$$

Taking moments about D

$$T \times p + W_C \times d = R_A (a+d).$$

Putting in the value of W_C and R_A we have

$$T = \left\{\frac{x}{l}\,\frac{(a+d)}{p} - \frac{x-b}{p}\right\}.$$

Substituting these values of T, W_C and R_A, the general equation of equilibrium becomes

$$\left\{\frac{x}{l}\,\frac{a+d}{p} - \frac{x-b}{p}\right\} \sin(\alpha-\beta) + \frac{x-b}{d}\sin\alpha = \frac{x}{l}\sin\alpha,$$

$$\therefore x\left\{\frac{(a+d)\sin(\alpha-\beta)}{pl} - \frac{\sin(\alpha-\beta)}{p} + \frac{\sin\alpha}{d} - \frac{\sin\alpha}{l}\right\} = \frac{b\sin\alpha}{d} - \frac{b\sin(\alpha-\beta)}{p},$$

$$\therefore x\left\{\frac{p(a+b)\sin\alpha - bd\sin(\alpha-\beta)}{b}\right\} = l\left\{p\sin\alpha - d\sin(\alpha-\beta)\right\},$$

$$\therefore x = \frac{bl\left\{p\sin\alpha - d\sin(\alpha-\beta)\right\}}{\left\{p(a+b)\sin\alpha - bd\sin(\alpha-\beta)\right\}}.$$

To determine the value of x from the graphical construction.

Referring to Fig. 1: Let R C be denoted by h_1 and S D by h_2.

Then

$$h_2 = \frac{p}{\sin\beta},$$

also

$$h_1 = h_2 - \left\{\frac{d\cos\beta}{\sin\beta} - \frac{d\cos\alpha}{\sin\alpha}\right\}.$$

$$\therefore h_1 = \frac{p}{\sin\beta} - \frac{d\sin(\alpha-\beta)}{\sin\alpha\sin\beta}.$$

From Fig. 1 we have

$$PQ = \frac{h_1(l-x)}{a} = \frac{h_2 x}{b}$$

Substituting above values of h_1 and h_2

$$\left\{\frac{p}{\sin\beta} - \frac{d\sin(\alpha-\beta)}{\sin\alpha\sin\beta}\right\}\frac{l-x}{a} = \frac{p}{\sin\beta}\cdot\frac{x}{b},$$

$$\therefore x\left\{\frac{p\sin\alpha - d\sin(\alpha-\beta)}{a\sin\alpha} + \frac{p}{b}\right\} = \frac{l}{a}\left\{\frac{p\sin\alpha - d\sin(\alpha-\beta)}{\sin\alpha}\right\},$$

$$\therefore x = \frac{bl\left\{p\sin\alpha - d\sin(\alpha-\beta)\right\}}{\left\{p(a+b)\sin\alpha - bd\sin(\alpha-\beta)\right\}}.$$

This expression is identical with the one obtained analytically, proving the accuracy of the construction.

Fig. 2 shows the construction for member D H for the case in which the load is transmitted to top joints. The same members are used; the construction, however, is reversed.

Particular cases showing the application of construction to the more common type of girders are dealt with in Figs. 3 and 4. Fig. 3 is an example of a girder with curved top flange and straight bottom flange. Fig. 4 shows the Warren type of girder.

In the latter case, as in all cases of parallel flanged girders, the angles $\sphericalangle\alpha$ and $\sphericalangle\beta$ become 90 deg., and the expression for x reduces to

$$x = \frac{bl}{a+b}.$$

It can be readily shown that this expression agrees with the graphical method.

In conclusion it might be noticed that the position P considered above will be the point at which the influence line, for the member, cuts the base. Thus in designing we are enabled to fix the position of the loads giving the greatest stress in any web member, hence the importance of the above construction.

Fig.1. MEMBER DH.

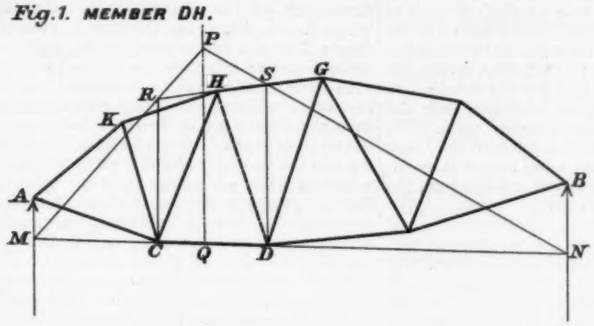


Fig.1a.

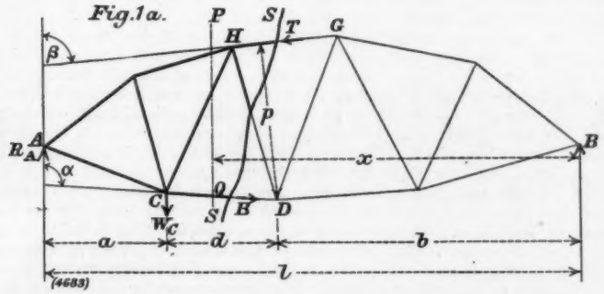


Fig.2. MEMBER HD. LOADS CARRIED TO TOP JOINTS.

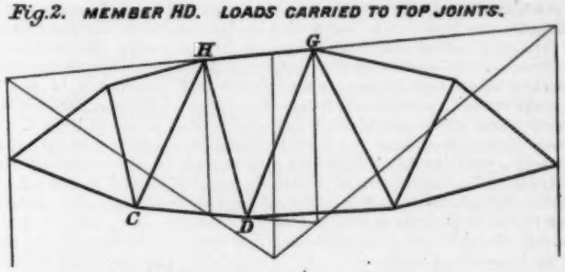


Fig.3. MEMBER CH.

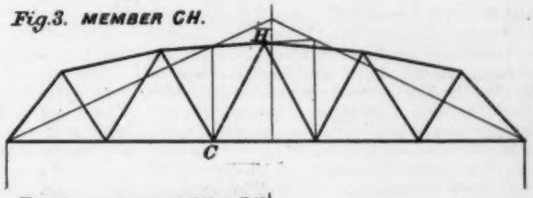
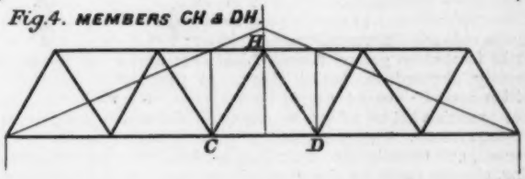


Fig.4. MEMBERS CH & DH.



RUSSIAN MANGANESE.—Manganese ore is being produced in the Gaisinsk district, in the province of Podolia, near Hosheratovo. The natural supply, a pyrolusite, is considered large. The distance of the source of supply from Odessa by railway is 221 miles.

THE ARRANGEMENTS OF MACHINE SHOPS.—No. I.

By JOSEPH HORNER.

THE best possible arrangements of machine tools in shops, and the methods by which they can best be served, forms a live subject of much interest at the present day. It embraces much more, and covers a far wider field than it did of old. In the still recent past new machines were dumped down in any area that happened to be vacant, almost totally regardless of the proximity of machines of other kinds. No attempt was made to co-ordinate similar operations, to avoid waste of time in transport, or to organise and dispose all the auxiliary services in strict relation to the machine production. It is now proposed in a short series of articles to give a number of drawings of shop plans and elevations, with their services. These will all be examples of recent growth and may be regarded as fulfilling the requirements that a modern plant is expected to possess. We will preface these descriptions with a brief statement of the general conditions which must be borne in mind when laying out machine shops.

Many matters have now to be regarded in planning and arranging a shop in full harmony with modern requirements. It is necessary first that the building itself shall be suitably designed. Also that it shall be provided with a service of hoisting, of transport, of service and of storage adapted specially to the different groups of machine tools and their products. Collateral aspects are those of light, of power supply and transmission, of the relation of the groups of machines to each other, and in a general engineer's works to the disposition and lay-out of the factory of which the machine shop is usually the largest and most important unit.

Machine tools are classified for the purpose of shop-planning either as being light or heavy, or by the nature of the operations which they are designed to perform. As the lighter ones, in most shops, far outnumber the heavy, these are usually grouped in classes. The heavy machines, being more limited in numbers, are frequently not so grouped. Again, while in some shops there are no heavy tools, in some others they vastly preponderate. All depends on the class of manufacture done. The extremes therefore are reflected in shop arrangements which assume a radically different character. Heavy tools must be located on ground floors. Light ones are frequently disposed in storied shops. In these, provision must be made for rapid intercommunication of materials between floors by means of lifts or conveying systems. The transmission of power is also influenced, and the selection of the best methods of driving, also the problems of storage, of supervision, of heating and ventilation. The storied shops, therefore, present problems almost peculiar to themselves.

The general character of the building or buildings in which machine tools are housed is governed by local environment. The old shops were always located in towns and cities in which lateral expansion could only be obtained by paying almost prohibitive prices for land and for the old houses that stood on it. Consequently buildings were extended upwards and the storied workshops were most commonly adopted.

When arranging new machines in an existing shop already occupied with a large plant, difficulties occur which are not present in the same degree when a new plant is being laid down. The problem is not solved by the mere location of a machine, since the storage racks, stands, boxes, or whatever happens to be required for the service of the machine have also to be accommodated. Good light thrown on the work itself is also essential, particularly so in gear-cutting, grinding machines, and turret lathes, where the attendant must be able to see his work on all sides. At present the large brand-new factory is usually planted miles away from a city in the midst of a rural suburb, in which healthy homes for the workers are erected. Hundreds of such factories have been built within the last few years. Having an ample area of relatively cheap land, the temptation to extend skywards is not present. Then the question of shop-planning is greatly simplified, resolving itself into that of the determination of the arrangements which are the most suitable for the character of the work to be done, all unhampered and untrammelled by the dead hand of existing shops. And still the answer will often be in favour of the storied building when the work is mostly small and light, as in brass goods, electrical apparatus, small motors, engines, pumps, and so forth. But when the main product is heavy but combined with a considerable proportion of light parts, the old system of a ground floor absolutely, or one surrounded with galleries, is still the best. If the output is uniformly massive, or only even fairly heavy, the single-floor building must have preference.

The ground-floor buildings are therefore properly and reasonably favoured more than the storied buildings are when new works are being laid down, even when the articles of manufacture are not uniformly heavy. Their superior advantages are these: If ample land is available the buildings can always be lengthened, with uniformity maintained in cross section, with the economical benefits that result from building with the same units of columns and roof principals, from duplicating the same hoisting machinery, and from extending the same floor tracks or transport systems. Further, there is the valuable asset of ample roof light with no shadows such as occur when stories are lighted from windows in the walls. Moreover, against the construction of storied buildings is the need of making very substantial floors and of providing lifts for communication. The provisions for warming and ventilation have also to be multiplied. For these reasons, unless when land is valuable and area restricted, the one-floor shop is now regarded with much more favour than the storied building for all classes of manufacture, the lightest alone perhaps excepted.

And yet, on the other hand, circumstances and conditions rather than ideals are the practical controlling facts which must often determine selection. Many firms who laid out works on what seemed model lines 20 years ago find themselves now working under conditions that have become somewhat antiquated and congested. This has happened in some instances solely in consequence of the extension of business which has to be carried on among hampering surroundings. In other circumstances the unsuitability of the factory has been a consequence of a new class of manufacture having been undertaken. Very many old firms who were formerly general engineers now specialise in some one or in a few articles only. Many who undertook a few groups of products similar in character have now restricted their energies to the manufacture of one or two, having discarded some in order to be able to specialise closely in others. These examples are commonplaces of knowledge. But what concerns this subject is the result, that the older arrangements are not adapted or even adaptable to the new conditions, and hence these firms are often compelled to abandon the excellent ideal schemes which they would desire to carry through in favour of some unsatisfactory compromise. In a fair number of instances the compromise takes the form of a separation between the old works and the new, the first remaining in the town, the second being located right away in the country. This arrangement entails additional expense for transport with motor lorries or railway trucks. Generally when the work done is appropriate, the lighter details are apportioned to the old works and the heavier to the new. The old shops then may be of the multi-storied design, the new ones built on the one-floor system. Usually the problem affects and includes departments, which, though lying outside the machine shop, are yet vital elements in the factory organism and which should, when possible, be disposed with the object of facilitating the general handling of the work. The foundry, the smithy, the stores for raw materials, should as a rule be properly located between the machine shops and the place of delivery into the works. Railways of standard or of narrow gauge should form a connection between the place of delivery and the various shops, and with the shipping department. And the lay-out should be such that movements of material and work shall be direct and progressive from the raw materials and rough castings and forgings through the several departments to the finished product.

The subdivision of the tasks performed by the machines should be arranged as far as possible to fit in with the big general scheme. To some extent this concerns the sequence of the tooling operations done on the different parts. But this can scarcely be worked out in detail on permanent lines, because methods may be changed with advantage from time to time. The best grouping which can be effected is that of machines of one kind, and of machines with some fair approximation to dimensions. This is convenient also for driving. Sometimes the groups of similar machines are located in shops separated from one another, but that does not seem a desirable arrangement either from the aspect of transport, lighting, or of general supervision. A clear, open, unobstructed building possesses every advantage without any drawback. Different kinds of machine tools can be grouped in classes and served suitably by hoisting and transport systems.

When a new machine shop is being planned with ample space available, the shop is designed not only to include the machines which are to be laid down, but usually leaving some areas for future additions. If the area of the shop is limited by surrounding blocks, the difficulties which may arise in the future consequent on the cramped space must be well weighed. In either case the way to proceed is to draw a floor plan of the shop to scale, and on this to make tentative arrangements of the machine tools with their auxiliaries and accessories. The over-all dimensions which must be taken as a basis are greater than the dimensions of bases or beds, being often double these or more—planer beds to wit—and including also the necessary spaces required round slotting machines when connecting rods are being tooled. Having estimated the over-all dimensions necessary or desirable, pieces of cardboard may be cut to represent the same dimensions on the same scale as the shop floor plan and placed about and rearranged until the most suitable locations are determined.

The operator himself has to be considered when locating his machine. He requires a clearance space not only to permit of freedom for his movements, but also to avoid danger from the moving parts of adjacent machines, or of the work which is set upon them. The planer is the source of most risk from this cause. Bad accidents have happened from workmen having been caught by articles carried on the moving tables and projecting beyond their ends. The danger of spacing machines too closely and of littering the floor with work is accentuated by the fact that the machines are in motion. A man in stumbling may put out his hand to save himself and get it caught in a moving part. Or he may be thrown bodily against it. This is liable to happen where parts are in shadow and when men are engaged in loading and unloading trucks or slinging work in cranes. It affords a reason for wide spacing between machines and for leaving large gangways unobstructed.

The positions of the machine auxiliaries, the numerous stands, racks and benches, must be located at the same time and by the same methods. These auxiliaries now occupy a far more extensive and important place in the scheme of the machine shop than they did at earlier periods. In the older shops the service of the machines was mostly limited to a few stands for receiving the stock to be used up, the castings and forgings to be tooled, mandrels, chucks, and other helps. But even then the floor was often utilised as the "top shelf," being strewn with castings and forgings, rough and finished, over which one had to pick one's way and which became serious obstacles to movements in the badly lighted shops when night work was being done. Only when the pile assumed unwieldy proportions were the finished articles wheeled away and jumbled in a so-called stores without any attempt being made to keep an accurate record of the pieces. Sometimes parts were lost, having been bundled away under benches or covered and smothered by larger articles, and then time was wasted in searches and questionings. Sometimes, too, spoiled work was put away surreptitiously along with the accurately finished stuff, and the errors were not discovered until the work came into the hands of the fitters and erectors. Small tools, again, were too frequently unprovided with racks or stands. The end of a lathe bed was frequently littered with the turning tools, totalling to several hundredweights of steel. For other machines a tool-box

of some kind was necessary. Just an old wooden box, with or without a cover, in which the tools, mandrels, chucks, &c., were thrown indiscriminately. Stands were exceptional luxuries. The utilisation of the machine base as a cupboard had not yet been introduced. The tool room was in the merest embryo stage. The tool forging and tempering was done by the tool smith. Templets, jigs and fixtures were crude, and were the work of a tool-fitter, a general handyman. It is difficult, perhaps, for the new generation, accustomed to the luxurious fittings and surroundings of the orderly machine shops of to-day, to realise the extent of the revolution that has been accomplished here. Yet all old craftsmen will recognise the accuracy of the picture.

The output of machine tools having been doubled or trebled by comparison with that of their very recent predecessors has accentuated and intensified the necessity for the location and arrangement of the collateral services of tool racks, stock and storage racks, cupboards, benches, stands and so on, as are best adapted to the services of each different class of machine or groups of similar machines. Even the cuttings produced by the tools of high-speed steel working on heavy lathes present a problem of removal which was scarcely considered a few years ago.

Whatever arrangements are adopted for the groups of machine tools, an unobstructed gangway or gangways down the shop is essential. This can never be encroached on by the machines and the work which they carry, or the racks and stands, without interfering seriously with the work of transportation and the service of the machines. Generally the racks and stands should be disposed behind or between the machines.

The problem of the proper storage of small tools and gauges, templets, jigs and fixtures, grows in importance with the increasing dimensions of shops. Out of it the tool room was developed. The old practice of allowing each man to accumulate a large array of tools, for the efficiency and upkeep of which he alone was responsible, is impossible in a big shop.

Fig. 1.

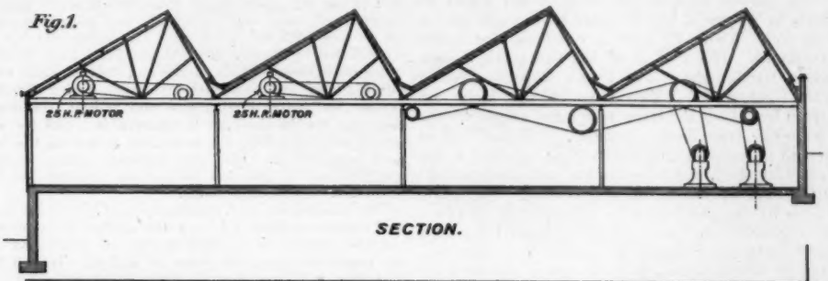


Fig. 2.

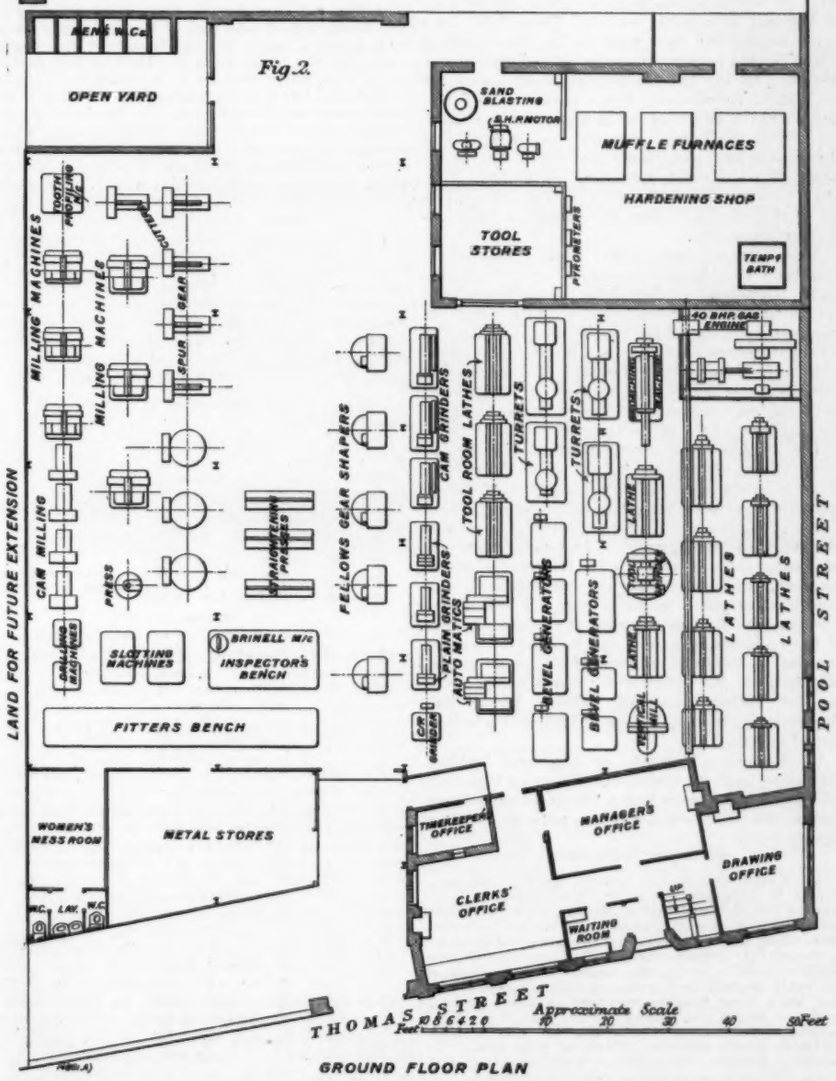
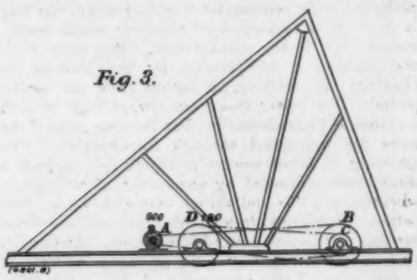


Fig. 3.



It works very well in the small shop because of the close personal control which is exercised there. As shops increase in dimensions the supervision of the individual is displaced by that of the organisation. In this the small tools and the fixtures are located in a department where they are maintained in their working efficiency, and whence they are checked out to the men, to be returned there after use. In the small shop, set arrangements for storage are practically ignored beyond perhaps the provision of one or two stands for the general service. In large shops one sees highly elaborated systems in use in the tool room and in association with it. Broadly they include the use of drawers in which small tools are put into racks of suitable shapes, so fitted that the edges of the tools are not permitted to come into contact with each other, to their mutual damage. Another common method is the hinging of a number of boards in a vertical axis, around which they can be turned, as in exhibits of prints in museums and of post-cards. Wooden pegs are fitted into the boards, and on them milling cutters and ring gauges are slid. The edges are preserved and the bores are not damaged. Solid cutters with shanks, as milling cutters, drills, taps, may be stood in centre-bit holes bored in blocks of wood, on which the sizes are stamped. These are kept on a bench or protected from dust in a deep drawer. Templets, jigs, and fixtures require more extended methods. Some have holes by which they may be hung on wooden pegs. But generally they are oiled and put away on benches or shelves in the tool room, or in the stores.

Every type of machine without exception, every group of machines of one type, becomes the centre of a series of problems peculiar to itself. These concern the service of tools and appliances, the hands, and the nature of the supervision. Frequently in a modernised establishment these problems are associated closely with the appliances and tools, the fixtures, jigs, and specialised tools that are used in connection with them. Examples illustrative are the equipments of the turret lathes, of the boring machines, of the milling machines, and of the gear cutters. These embrace a large and costly stock of aids for holding tools and work, a stock which is always growing, and for which orderly provision has to be made in tool room, in racks, in stores, if they are to be readily available when wanted.

The question of driving machine tools is open to three solutions. The older method of a line shaft extending throughout the length of a shop from which the rows of machine tools are served, the more recent methods of driving a small group of machine tools from a short line shaft, itself motor-driven, and that in which each machine is provided with its own individual motor. In the second case belt drives have to be retained, with the disadvantages which are inseparable from the employment of belts. Yet for small machine tools that is often accepted as preferable to the long line shaft, because it permits of the ready disconnection of any one group from the others. In the older system it was not unusual to see a long line of shafting running for the purpose of driving two or three machines on which overtime was being worked, representing a terrible waste of

power lost in friction. The third or individual motor drive is commonly reserved for the larger machines, for which it possesses several advantages. The scope of its application is extended in many machines to include a separate motor for each major movement, each rated, as are the motors for cranes, for its own particular duty. When new plans are being contemplated or laid down, the way is clear for the adoption of a system which recommends itself to the management. But more often the problem is complicated by the presence of existing line shafting, a legacy from an earlier period. The power losses are always high in such a system if journals run in plain bearings, and if the belts are multiplied through countershafts. The grouping of a few similar machines driven from a short shaft controlled by one motor offers superior advantages. The individual motor drive is even better, but it is not often adopted for small machines because of the first cost of the motors. The group system is less expensive and at the same time it unites some of the advantages of the motor drive with closer localisation of the line-shaft system.

The relative merits of the belt *versus* motor drive have often been discussed, but it is well to recall the leading facts about each. Perhaps the difference which appeals most strongly to the manufacturing engineer is the fact of the great friction losses that occur in constantly running shafts and belts, these comparing unfavourably with those which only happen when a motor is actually running and driving. The first also occur in the group system. But they are localised, being apart from all other groups, each being run only when the machines which belong to it are required. Further, the control of the speeds of machine tools when driven from a line shaft is usually effected by means of the steps of cone pulleys. It was always exercised thus formerly, but a change has come over this time-honoured practice of late years. The box of change gears now nearly as frequently controls the varying speeds, and is itself driven from a single pulley, and this from a single or a two-speed countershaft. But still many, the majority doubtless, of lathes and other machine tools retain the stepped belt cones, with the resulting trouble and loss of time involved in belt-shifting, the seriousness of which increases with the width and weight of belts. In the motor drive the speeds are governed by the controller, the movements of which can be made very small through the several notches. If in addition machines have speed gears, the changes in speed are rendered very much more minute than those which occur between the steps of a belt cone pulley. The flexibility of the motor drive is therefore much greater than that of the line shaft. With reference to the belt or the all-motor drive, the advantage from the mechanical point of view lies with the latter, though the outlay on motors is a serious set-off to that advantage. The disadvantages of belts are too well known, especially when they are employed under unfavourable conditions. Wide, thick belts lack flexibility, and set up excessive friction. This is aggravated when the length of drive is short, the pulleys small, or the belt too tight. Compound belts and link belts reduce these evils. But in any case the motor possesses the advantage of being unaffected by the evils peculiar to belt drives. It can be rated to the work which it has to perform, to the heaviest or to the lightest cutting, with the certainty that its performances will not be limited by the method of transmission adopted. At the present time when tools of high-speed steel are generally employed and machines have been remodelled to absorb great increases in power, belting is regarded with more disfavour, and motor driving is being accepted as the better solution of the problem in large numbers of instances.

The foregoing preliminary remarks may serve as a text to be illustrated in diverse ways by the series of examples to follow.

The two views, Figs. 1 and 2, on page 73, show the plan arrangements and the cross section of the new workshop of the Moss Gear Company, Limited, of Birmingham. This is an example of a shop in its early stages, to which extensions are being made. There are also vacant spaces in the centre left open for machines which are on order. Presently there will be a separate inspection room, and tool room for work which is being done in the shop at present. The firm is largely engaged on war work. The speciality of the firm is the production of cam-shafts and gears, and therefore the machine tools on which this work is done are of a highly representative character. The requirements of hardening are reflected in the equipment of the hardening shop, and Brinell outfit.

The ground area of this shop covers about 40 yards by 40 yards, but it tapers to 50 yards at the long end. About 1¼ acres is available for future extensions. The roof is of the saw-tooth design, giving north light. The longer slope is covered with "ruberoid." Two bays of the shop are driven by a 40-brake-horse-power gas engine by the Dudbridge Iron Works, Limited, of Stroud. It is located in one corner of the building adjacent to the hardening shop, and drives to line and countershafts in the roof, as seen in the shop section. The shaft driven by the gas engine on the first line carries a three-grooved rope pulley which drives the second line by three ropes of 1¼ in. diameter. The other two bays are driven by two 25-horse-power motors fixed in the roof, seen in the section. These drive on a countershaft and then back to the line shafting which is fixed between the principal and the motor, Fig. 3. All the line shafting runs at about 180 revolutions per minute. Fig. 3 shows the roof and the method of attaching the motors on cross-timbers supporting the joists. Here the motor A runs at 900 revolutions per minute and drives on to the pulley B on a short countershaft. On the same shaft is keyed the small pulley C which drives back on to the main line shaft D running at 180 revolutions per minute.

This is an example of that class of shop which handles a very limited number of specialities of a light character, so light that neither overhead travelling cranes nor fixed wall or other cranes are required. All the lifting can be done by hand, or by light portable jib cranes. Neither are tracks necessary. Cam-shafts and gears for the automobile and aeroplane trades can be handled easily. For any weights which are too heavy to be lifted by hand, patent chain hoists are used.

The machines are arranged strictly in parallel lines. They consist chiefly of gear cutters and grinders, with their satellite machines of turret lathes and automatics, plain lathes, straightening presses, &c., as may be observed from an inspection of the plan arrangements. In one corner the hardening shop is walled off. It includes muffle furnaces with pyrometers, a quenching bath, and sand-blasting plant, motor driven, and tool stores. The various offices are situated at the entrance end of the buildings, and these will be carried over the gateway at the front, in front of the metal stores. Machines not yet delivered for which vacant areas are left include universal millers, Potter and Johnston automatics, and more universal grinders, thread millers, &c.

The Moss Gear Company are at present building extensions to these works. In a year or two they will probably be much larger, but on the same lines, because the bays added will be similar to the four already built.

MANGANESE ORE IN THE UNITED STATES.—The production of manganese ore in the United States in 1915, says the *Iron Age*, was 9,651 gross tons, being the largest since 1901 and more than three times the production of 1914, which was 2,635 tons. The production of manganiferous iron and silver ores in 1915 was 798,404 tons, which was almost twice the output of 1914. Most of this latter ore was used in making high-manganese pig-iron, but a large quantity was used as a flux by lead smelters; 66,530 tons contained more than 15 per cent. manganese, and a large part of this was used to make low-grade ferro-manganese. There is good reason for expecting a further increase in domestic production during 1916 as a result of the high prices offered.

TRADE IN AUSTRALIA.—The latest return as to the annual tonnage movement of the ten principal Australian ports exhibits the annexed results:—Sydney, 9,018,785 tons; Melbourne, 6,128,266 tons; Newcastle, 4,661,703 tons; Port Adelaide, 3,505,443 tons; Brisbane, 2,832,819 tons; Fremantle, 2,399,275 tons; Townsville, 1,597,173 tons; Albany, 1,403,135 tons; Mackay, 1,067,835 tons; and Rockhampton, 1,000,302 tons. The tonnage movement of ten principal English ports was:—London, 20,088,071 tons; Liverpool (including Birkenhead), 15,574,989 tons; Cardiff, 12,603,349 tons; the Tyne, 11,701,605 tons; Southampton, 8,268,860 tons; Hull, 5,904,698 tons; Plymouth, 4,717,738 tons; Newport, 3,630,681 tons; Middlesbrough, 3,416,582 tons; and Swansea, 3,374,439 tons.

40-TON TITAN BLOCK-SETTING CRANE.

In our article on the construction of the breakwater at Fishguard Harbour, published in our issue of July 7, page 5 *ante*, we promised to give drawings of the Titan crane utilised there for setting pell-mell the 40-ton concrete blocks forming part of the protection of the breakwater, as well as blocks, of corresponding and of less size, used in the construction of the breakwater itself, and on Plate IX and pages 75 and 82 we now fulfil this promise. The crane, which was constructed by Messrs. Stothert and Pitt, Ltd., to the order of Messrs. Topham, Jones and Railton, Ltd., who are carrying out constructional work under Messrs. Coode, Matthews, Fitzmaurice and Wilson, the engineers for the breakwater, is remarkable alike for its power and its radius, the maximum radius for the full load being 125 ft. This was necessary owing to the great spread of pell-mell block work required for the protection of the breakwater.

The dimensions and construction of the crane are well shown on Plate IX, and the method of carrying out the operations of block-setting are illustrated in two respective views on pages 75 and 82. It will be seen that the crane travels along the breakwater on two double sets of rails, each of standard gauge and at 30-ft. centres, while for the transit of the wagons conveying the blocks from the block-setting yard to the position where they are to be loaded, the crane has a clearance of 22 ft. and a headroom of 15 ft. 3 in. The crane travels on a truck carried by 32 central flanged wheels arranged in four rows. There are eight wheels in each row, four being driven by a chain in each row, making 16 driven wheels in all. The rate of travel is 42 ft. per minute with the 40-ton load. The superstructure is rotated on a platform 20 ft. 11 in. above rail level by means of a roller-path working on a live ring of 56 cast-steel rollers, each 12-in. in mean diameter. The slewing is effected by means of a pinion gearing with a large circular rack, 34 ft. 3 in. in diameter, fixed to the top of the truck. The jib makes one revolution in 3 minutes. The constructional details, alike of the bogie and of the slewing jib, will be seen from the drawings on Plate IX. The jib has a maximum depth of 23 ft.

List of Gears.

Mark.	Teeth.	P. Diameter.	Pitch.	Width.	Bore.	Remarks.
						Lifting.
		ft. in.		in.	ft. in.	
A	15	0 10	No. 1½	6½	0 4½	Mild steel, machine cut
B	49	2 8·66	,,	7	0 5	Cast steel ,,
C	46	2 6·66	,,	6	0 4½	,, ,,
D	17	0 11·33	,,	7	0 4½	,, ,,
E	55	3 0·66	,,	6½	0 5	,, ,,
F	13	0 10⅞	2½ in.	7	0 5½	,, 2 required
G	144	9 6½	,,	7	0 6½	Cast iron, 2 required
H	26	1 5·33	No. 1½	6	0 5½	,,
						Motions.
I	24	1 4	No. 1½	5	0 4½	Cast steel, mitre
J	24	1 4	,,	5	0 4	,, ,,
K	20	1 1·33	No. 1½	6	0 3½	,, machine cut
L	28	1 6·66	,,	6	0 4½	,, ,,
M	14	0 11.2	,,	5	0 4½	,, ,,
						Slewing.
N	78	5 2·4	,,	5	0 5½	Cast iron ,,
O	12	1 1⅜	3½ in.	7	0 5½	,, steel
P	44	4 1	,,	7	0 7	,, iron
Q	12	1 7½	5¼ in.	9	0 7½	,, steel
R	252	34 3	,,	9	—	,, iron, curb ring
						Racking.
S	14	0 8⅛	2 in.	4½	0 3½	Cast steel
T	57	3 0⅛	,,	4½	0 4½	,, iron
U	14	0 8⅛	,,	5	0 4	,, steel
V	130	6 10½	,,	5	2 8½	,, iron
W	26	1 4⅞	,,	5	0 4	,, steel
X	118	6 3⅛	,,	5	2 8½	,, iron
						Travelling.
Y	24	1 7½	2½ in.	5	0 4½	Cast steel
Z	24	1 7½	,,	5	0 4	,, ,,
a	13	1 0·74	3 in.	6	0 4	,, ,, bevel pinion
b	34	2 8⅛	,,	6	0 4½	,, ,, ,, wheel
c	11	1 0⅛	3½ in.	6	0 4½	,, ,, ,, pinion
d	22	2 0⅛	,,	6	0 4½	,, ,, ,, wheel
e	12	1 1⅛	,,	6	0 4½	,, ,, ,, pinion
f	25	2 3⅛	,,	6	0 5½	,, ,, ,, wheel
g	14	1 5·14	4 in.	6	0 5	,, ,, ,, pinion
h	21	2 2⅛	,,	6	0 5½	,, ,, ,, wheel
Sprocket	13	1 1·76	3¼ in.	1½	0 5½	,, ,, sprocket
Sprocket	27	2 4	,,	1½	0 8½	,, ,, ,,

The disposition of the machinery, which is mounted on the counterbalance end of the jib, along with 95 tons of ballast, is clearly indicated on the plan, Fig. 2. The hoisting barrel has a diameter of 7 ft. 10½ in., the lifting rope being of 3¾ in. circumference, and this is operated through spur gearing by a two-cylinder engine, with cylinders 11 in. in diameter and 18-in. stroke, supplied with steam from a Hopwood vertical boiler of 4 ft. 6 in. diameter by 10 ft. 3 in. high, working at a pressure of 100 lb. per square inch. The same engine is used for slewing and racking, through gearing working on the slewing rack and on the traversing chain gear. Two lifting speeds are provided, one for the full load of 40 tons at 8 ft. 6 in. per minute, the other

40-TON BLOCK-SETTING TITAN CRANE AT FISHGUARD HARBOUR WORKS.

CONSTRUCTED BY MESSRS. STOTHERT AND PITT, LIMITED, ENGINEERS, BATH.

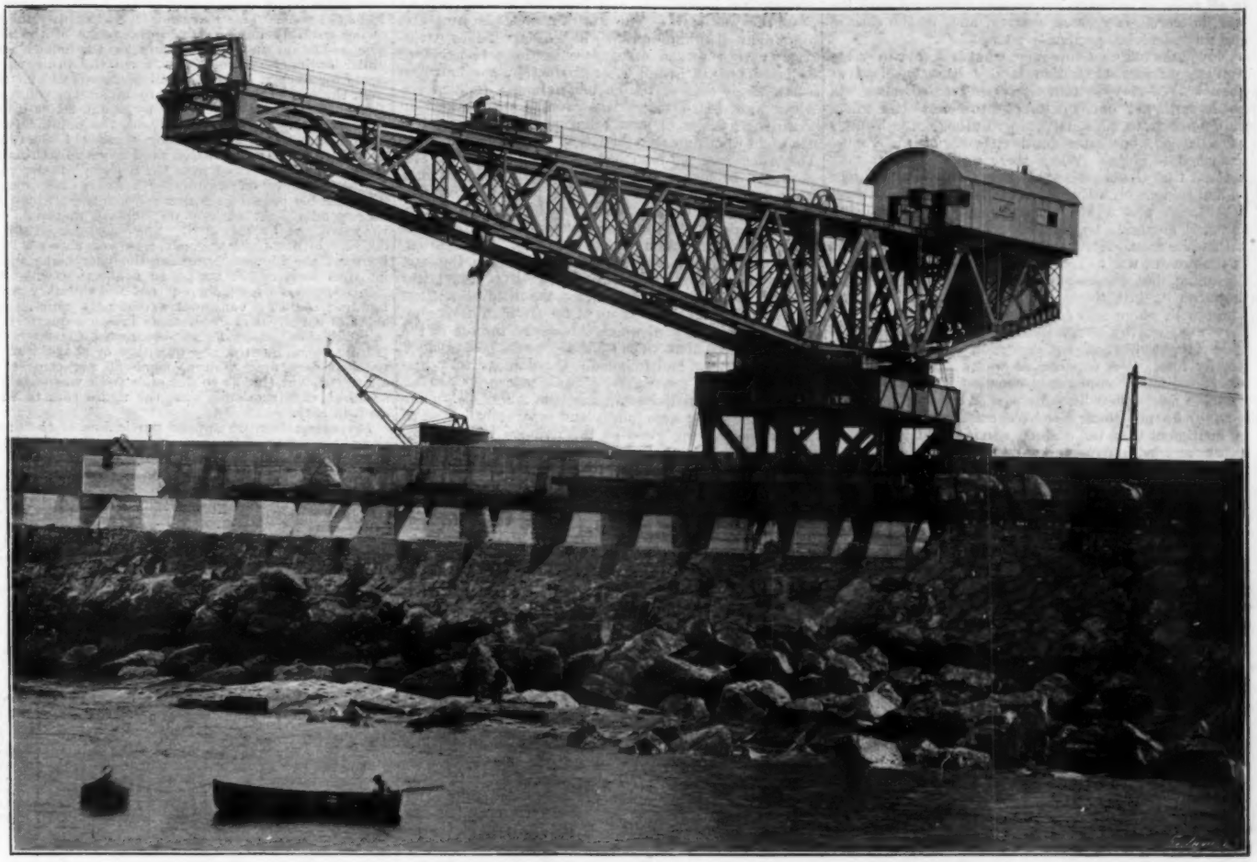


FIG. 4.

for a 7-ton load at 48 ft. per minute. The hoisting barrel is of sufficient capacity to enable the hook to descend 80 ft. below the rail level and to rise 40 ft. above, giving a total lift of 120 ft. Detailed particulars of the gearing are given in the preceding table, and the letters of reference to the various gears will be found on the illustrations on Plate IX.

The load is lifted on eight parts of rope, 3¼ in. circumference. The range of traverse for the racking motion is 97 ft., and the load is racked to and fro on a jenny by means of steel wire ropes 3 in. in circumference, led over pulleys at the outboard end of the jib, and thence secured to the racking barrel. The speed of racking is 22 ft. per minute with the full load, and 45 ft. per minute with the 7-ton load. The load is controlled in lowering by means of Matthews' hydraulic brakes, fitted with Peters' patent free-wheel. The hydraulic brake is 10 in. in diameter by 12 in. stroke, and, as shown in the plan, a water tank is fitted for filling and circulating.

There is also an electric generating set fitted in the machinery house. This set generates sufficient current for lighting and for driving a motor fitted on one of the truck bottom sills which operates a pump to deliver water from ground level to the feed-water tank in the machinery house, and also drives a capstan for hauling wagons along the road under the crane truck. There is on one side of the boiler a coal bunker with a coal davit for raising supplies, and on the other side a feed tank with the necessary donkey pump.

The whole of the operating gear is brought to a convenient position on a platform behind the centre of the crane, so that the craneman has a clear view of the load and all the machinery.

This is the largest travelling crane of its type yet built in this country, and it was tested with a load of 50 tons at 125 ft. radius. It has given great satisfaction in actual service on the breakwater.

INDUSTRIAL NOTES.

THE directors of Vickers, Limited, have given another proof of their care in improving the well-being of their workers by the erection at Crayford, Kent, of a large and beautifully decorated theatre for the entertainment and recreation of the munition workers. The theatre was formally opened on Wednesday night by H.R.H. Princess Christian, who had some months ago laid the foundation stone. On both occasions she was accompanied by her daughter, Princess Victoria. Mr. Albert Vickers, the chairman of the company, introduced Her Royal Highness to the large audience, and the opening of the theatre was signalised by Princess Christian striking a suitably-designed souvenir gong. The theatre has a large stage, which is fitted for all classes of entertainment, and has also a large organ, which on Wednesday was inaugurated by Sir Frederick Bridge, C.V.O., the organist of Westminster Abbey. This is the third theatre built by the Vickers Company, whose action is greatly appreciated by the workers.

We have received a copy of part No. 1, for the present month, of the publication entitled "Munitions of War Acts, 1915–16, Scottish Appeal Reports." It gives the details of the result of the appeal in eight recent Scottish cases under the Acts. The pamphlet is printed and published at the price of 1s. by Messrs. William Hodge and Co., Edinburgh and Glasgow.

A meeting of Working Class Associations was held at the close of last week at Oxford, under the presidency of Mr. C. W. Bowerman, M.P., when various papers were read. One on "The Disorganisation of Industry, Commerce and Finance: the Problems to be Faced," by Professor A. C. Pigou, Cambridge, stated that a great danger might arise in the transition from war to peace conditions, unless steps were taken to ensure that wage-earners be rapidly returned from active service to their ordinary work. Government, he thought, should see that both employers and employed made full use of the employment bureaux, so that no delay resulted in getting men back to their ordinary employment. Any necessary interval to secure this should take the form of a well-earned holiday at the expense of the State. If, when peace came, wage disputes arose between employers and employed, and led to widespread stoppages of work, then the re-starting of the country's economic life would be delayed. In order to prevent such stoppages, recourse would no doubt be had to discussion and to arbitration; but unless there were some common bases upon which the mediators could agree, satisfactory settlements would, he feared, not be arrived at. He anticipated that there would be considerable emigration, and that many women would continue in industrial labour. Mr. Arthur Greenwood, of Leeds University, also contributed a paper in which he stated that after the war the Labour Party should take in hand the problem of industrial reconstruction; he thought they could best do so by calling a national conference of employers and employed, having full power for the adjustment of all differences. He hoped that when peace was proclaimed a National Council of Industry and a Minister of Labour would be set up, with a view to facilitate the work of demobilisation and the return of the men to their usual avocations. The problem of women's labour would be found a difficult one to settle. In regard to paying the cost of the war, one way, according to one of the delegates present, Mr. Sidney Webb, was to increase production; he thought production could very well be advanced by at least 10 per cent. Collective ownership and co-operation, he added, were two steps towards an ideal national reorganisation which would combine efficiency with liberty. An

increase of 10 per cent. in productiveness, he stated, would pay the whole cost of the war, as also would nationalisation of the railways or of the coal mines.

No one who studies the technical journals of the home Press, says *Indian Engineering*, Calcutta, can fail to be impressed by the reiterated cry that labour in all fields of industry, for reasons connected with the war, is scarce, is growing scarcer, and, in the case of certain industries, perilously so.

Now, asks our contemporary, what is it that prevents the large forces of Indian labour being utilised at home? We may be told that the Trade Unions will not have them; but it is difficult to believe this when, in deference to national opinion, the Trade Unions have let go, one after another, many of their most cherished formulæ. When there used to be fighting before, the Government at home refused to place Indian soldiers on a European battlefield on the ground that there was a strong sentiment against placing coloured men side by side with white men in conflict with white men. What has happened to that sentiment in the present war? There was a faint echo of it at the beginning, but the coloured men were there and the prejudice against them disappeared in a few weeks. Those with whom they fought side by side soon learned they were worthy comrades, and those against whom they fought learned equally soon that they were worthy foes. The experiment was a success and the reports of field commanders constantly testify to the valuable work they have done. We (*Indian Engineering*) do not think a service exists more governed by sentiment than the military service, and if Indians have succeeded in overcoming adverse sentiment on the field, they will also overcome it in civil employment. In the latter, besides the sentimental objection, there is no doubt also an economic objection similar to the one prevailing against Asiatics in British colonies; but we do not advocate importing a large force of Indian labour into England and permitting it to continue there permanently. Just as our Indian troops will be returned to India at the end of the war, so must Indian labour taken to England for specific civil employment connected with the war be sent back as soon as such work is done. Indian labourers would be of value in shipyards and would even be useful to supplement British labour in the coal mines. As miners their efficiency would be well below that of British workers, but they need only be paid according to their efficiency. In the shipyards it would be found that Indian carpenters and smiths would give an excellent account of themselves, and enough could be got from the Punjab alone to tide shipbuilders over their temporary difficulties.

We constantly hear, continues our contemporary, of the inefficiency of Indians in industrial employment, and constantly try to encourage them to produce better work and more work. We have never tried the effect of drafting them to British shops where they would see the standards observed and would automatically emulate them. If during this labour crisis a large body of Indian workers were given the chance of working for some months in the best British establishments they would return to the country with their ideals transformed, the practical education they would bring away with them would be worth more than all the teaching they ever get in this country, and their example would leaven in a very appreciable degree the standard of labour in India.

The widespread "Safety First" movement which, according to *Engineering News*, New York, has had such a wonderful effect in the railway service and in industrial establishments in reducing the number of accidents to workmen, is receiving attention also in engineering construction work. It is much more difficult to train the shifting force of workmen employed on the average construction contract to observe safety rules than it is to educate the more permanent employees who work on a railway or in a machine shop. The engineer who wishes to reduce accidents to those working under him, therefore, usually gives closer attention to guarding machinery and to the safe handling of explosives.

It seems worth while to call attention to one simple safety appliance that ought to be much more generally used on construction work, and that is, goggles for the protection of the eyes where men are engaged in chipping stone or metal, or in other work where the eyes are likely to be struck by flying particles. It is fortunate that the wide use of automobile goggles makes it possible to obtain for workmen almost anywhere now, and at a trifling sum, eye-protecting apparatus that is generally entirely satisfactory. Not only this, but the custom of wearing goggles, which the automobile has established, has gone a long way towards eliminating the prejudice against their use and has made it much easier to induce workmen to wear them.

In handing to the Press representatives a copy of the resolutions passed at the Allies' Economical Conference held in Paris from June 14 to 17 last, M. Clémentel, the French Minister of Commerce and Industry, explained to them the aims of the Conference. Among his statements on that occasion, as reported by the Comité des Forges de France, he said that the Allies were economically stronger than the Central Powers. The Allies had a population of 400,000,000 inhabitants and held the greater portion of all raw materials. The ores of nickel, platinum and aluminium (bauxite) were owned by the Allies exclusively; they owned manganese in the proportion of 84 per cent. In hemp, their production was four and a-half times that of the enemy nations; in flax, the Allies held four-fifths of the world's production; in wool, their power of production was 11 times, and in silk eight times greater than that of their adversaries. The Allies had the monopoly of the jute output, and in regard to cotton, the neutral countries shared in a large measure with the Allies the production of this commodity, whilst the enemy nations did not produce any at all. In the course of the legitimate economical defensive action which had thus been started, the neutral nations had no attack to fear on the part of the Allied Governments; the work of the latter would have for effect to render the neutral nations quite free, for the breaking up of the German hegemony would set aside a peril which threatened the life of the said neutral nations. The Central Powers had pillaged the regions they had invaded; the damage they had thus caused did not weigh in equal measure upon all the Allies, but, notwithstanding, the Allies had made it clear that they were jointly and separately bound to aid in the making good of the damage in question. For example, Great Britain would supply to France the textile machinery she required before exporting such machinery elsewhere. On the other hand, the Central Powers would be bound to make restitution. The economic agreement arrived at by the Allies was already in itself a victory. Clause 11 of the Treaty of Frankfort, styled the most-favoured-nation clause, which formed a powerful weapon in the hands of Germany, was henceforth dead.

The half-yearly meeting of the Manchester Chamber of Commerce was held last Tuesday, when Mr. R. B. Stoker, the President, stated that the German method of waging war and their treatment of our wounded soldiers and interned and other civilians had created a loathing of all things German which would take years of peace to eradicate. But despite the fact that warnings given before the war had been verified up to the hilt, there were still to be found, even in Manchester, some few men who would after the war trade with Germans on the old misguided lines, and allow them to recommence without let or hindrance their old discreditable methods. With regard to the settlement after the war, he advocated restitution by Germany in kind as well as in cash. British shipowners, in view of the fact that some 1,500,000 tons of our shipping had been destroyed by our enemies, would be justified in insisting upon the German mercantile marine being handed over ton for ton.

The journal *Indian Industries and Power* announces the formation of the Indian Industries Commission, and says that the work before that body has been dealt with by Government in its statement to the effect that the time has now come when the question of the expansion and development of Indian manufactures and industries should be taken up in a more comprehensive manner than hitherto. India possesses two notably successful manufacturing assets in the two great textile industries of cotton and jute, and there are others which have also reached some degree of importance, but it remains none the less true that she is still in the main a producer of raw materials. The Government of India, however, have strong hopes that it may prove possible to place the industries of the country on a much firmer and more extended basis than at present, and they consider that no means should be left untried which holds out a reasonable hope of effecting this end. They are aware of the eager desire of a large number of the people of India for the industrial development of their country, and with this desire the Government of India fully associate themselves. But Indian capital is timid and unenterprising, skilled labour is lacking, and there is a want of practical information regarding the commercial potentialities of India's raw products. All these difficulties require full examination by men of technical experience and high business standing. The Government of India have therefore decided to appoint the Commission in question, the President of which is Sir Thomas Holland, and the Secretary Mr. R. D. Bell.

THE RUSSIAN PRESS.—We have received from Messrs. Neyroud and Sons, Limited, Foreign Advertising Agents, Regent House, Kingsway, W.C., a copy of a booklet they have issued giving a list of the most important Russian newspapers, periodicals and trade journals, arranged under towns and under trade specialities.

THE GERMAN STEEL UNION IN 1915-16.

ALTHOUGH the conditions of delivery were more favourable during the year ended June 30, 1916, than during the previous 12 months, when military transports monopolised the railways for a time, the aggregate quantity of steel despatched by the Steel Union fell somewhat short of the figures of the previous year, the quantities being respectively about 3,245,000 tons and 3,393,537 tons. This reduction is, no doubt, principally owing to Italy having joined the ranks of the Allies. The reduction naturally occurs in the goods which, under ordinary circumstances, form the principal products for export, especially railway material and shape iron, the former being reduced by about 171,000 tons to 1,588,060 tons, and the latter by about 90,000 tons to 804,000 tons. On the other hand, the manufacture of half-finished steel increased by some 114,000 tons to 853,000 tons. The increased production of half-finished steel naturally resulted from the activity of the rolling industry proper on account of military requirements. Considerable orders from neutral countries, which have to depend almost entirely on German material, could therefore not be executed. Since October, 1915, the delivery of half-finished goods, however, shows a steady increase, the highest figure for the year being reached in April with 83,132 tons. In connection with shape iron it must be remembered that the ordinary private building industry continues exceedingly quiet. Slight signs of a revival are noticeable in some quarters, and re-building in Eastern Prussia is expected to help matters. During some months the quantity of shape iron despatched only amounted to some 25 per cent. of the allotment, but thanks to demands from wagon-building and iron construction works, the figure rose to 42 per cent. in May.

For comparison we append particulars of the quantities of the different leading goods despatched during the month of June for the last three years:—

	1914. tons	1915. tons	1916. tons
Half-finished goods ...	130,998	77,804	77,483
Railway material	252,056	154,737	134,585
Shape iron	182,099	86,412	86,685

The aggregate of these quantities during June, 1916, was 55.5 per cent., against 59 per cent. of the allotment in June, 1915, and for the different classes the delivery amounted respectively to 68.7 per cent., 62.8 per cent. and 41.2 per cent. of the allotment.

As regards the ruling quotations during the last financial year, those for half-finished goods and shape iron showed some increase, which will appear from the subjoined table:—

	Ingots per Ton	Billets per Ton	Bars per Ton	Plates per Ton	Girders per Ton
	marks	marks	marks	marks	marks
3rd quarter, 1915 ...	102.50	107.50	115	117.50	130
4th quarter, 1915 ...	102.50	107.50	115	117.50	130
1st quarter, 1916 {	102.50	107.50	115	117.50	130
	102.50	112.50	122.50	127.50	140
2nd quarter, 1916 ...	107.50	112.50	122.50	127.50	140

With regard to these prices, it should be noticed that according to the decision at the meeting held on December 16, 1915, no alterations were to be made in the quotations for the first quarter of 1916. At the general meeting held on January 20, 1916, the sale for the second quarter of the present year was given free at a rise of 7.50 marks for billets and bars and 10 marks per ton for plates, and it was decided that this increase in price should also apply to all contracts subsequently entered upon during the first quarter of the year. In a similar manner the price for girders was raised 10 marks per ton. In the beginning of May the sale was given free for the third quarter of the current year at an increase of 20 marks per ton for half-finished products and shape iron. This latter rise was much criticised by consumers, but their expectations of a reduction in the 20 marks rise are not likely to be fulfilled. However, a further increase of the quotations is not anticipated.

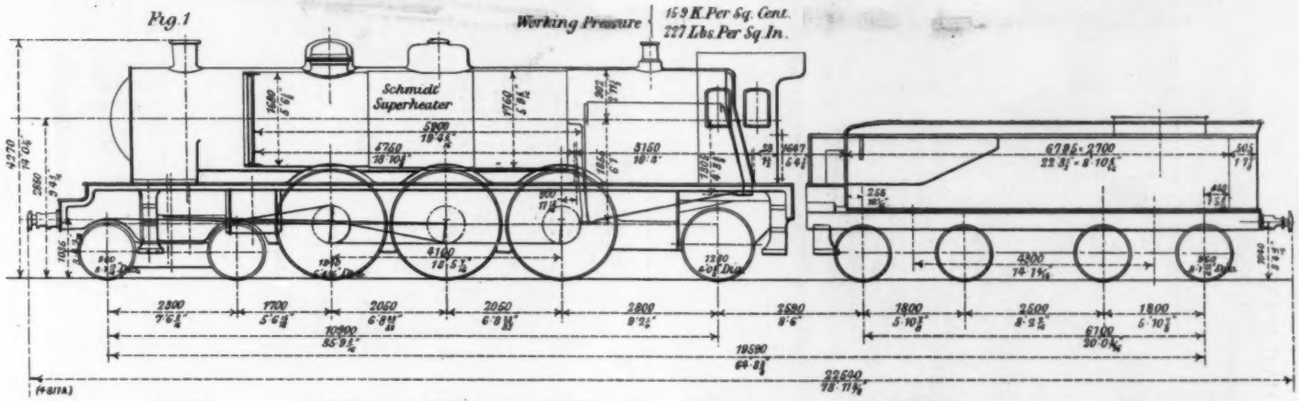
AMERICAN TRADE.—The exports of merchandise from the United States in May exceeded those of any preceding month in American history, the total value being 472,000,000 dols., or 300,000,000 dols. more than the monthly average from 1911 to 1914. The imports for May were also the largest on record, the total value being 229,000,000 dols., or an increase of 11,000,000 dols. over April, 1911, which beat all previous monthly records. The excess of American exports over American imports for the 12 months ending May, 1916, was 2,026,000,000 dols.

RESTRICTIONS ON USE OF ALUMINIUM.—The Secretary of the Ministry of Munitions forwards the following for publication:—In pursuance of the powers conferred on him by Regulation 30A of the Defence of the Realm (Consolidation) Regulations, 1914, the Minister of Munitions hereby orders that the war material to which the Regulations apply shall include war material of the following classes and descriptions, namely: aluminium and alloys of aluminium, unwrought and partly wrought, including ingots, notched bars, slabs, billets, bars, rods, tubes, wire, strand, cable, plates, sheets, circles, strip, granulated aluminium, aluminium powder, "bronze," "flake" and "flitter." The Order, dated December 7, 1915, published in the *London Gazette* of the same date, relating to all kinds of aluminium and alumina, is hereby cancelled. All applications for a permit in connection with the above Order should be addressed to the Director of Materials, Ministry of Munitions, Armament Buildings, Whitehall Place, S.W.

EXPRESS PASSENGER AND GOODS LOCOMOTIVES FOR THE FRENCH STATE RAILWAYS.

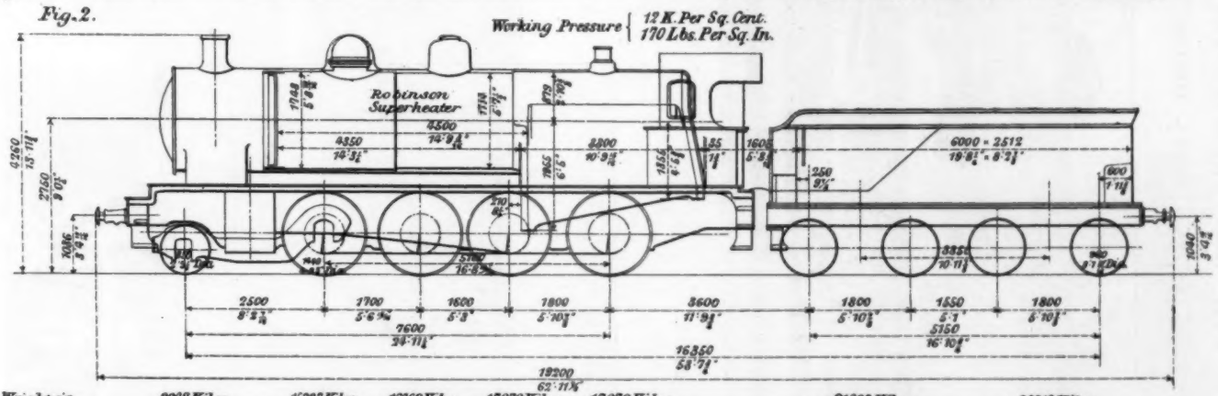
CONSTRUCTED BY THE NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED, GLASGOW.

Fig. 1



Weight in Working Order	22506 Kilos. 22 Tons 3 Cwts.	19273 Kilos. 18 Tons 19 Cwts. 2 Qrs.	19279 Kilos. 18 Tons 19 Cwts. 2 Qrs.	19102 Kilos. 18 Tons 16 Cwts.	16386 Kilos. 16 Tons 2 Cwts. 2 Qrs.	24741 Kilos. 24 Tons 7 Cwts.	27763 Kilos. 27 Tons 6 Cwts. 2 Qrs.

Fig. 2.



Weight in Working Order	9042 Kilos. 8 Tons 18 Cwts.	15395 Kilos. 15 Tons 3 Cwts.	16460 Kilos. 16 Tons 4 Cwts.	17070 Kilos. 16 Tons 16 Cwts.	17070 Kilos. 16 Tons 16 Cwts.	21693 Kilos. 21 Tons 7 Cwts.	23518 Kilos. 22 Tons 19 Cwts.

On the present page and pages 78 and 79 we give illustrations of some passenger locomotives for express service and some heavy goods locomotives recently constructed by the North British Locomotive Company, Limited, of Glasgow, for the French State Railways.

The passenger engines, of which a general diagram is given in Fig. 1, above, and of which further illustrations will be found in Figs. 3 to 6, on page 78, are four-cylindered compounds of the "Pacific" or 4-6-2 type, a class which, in the French notation (which takes account of axles instead of wheels) is known as the 2-3-1 type. The high-pressure cylinders are 420 mm. ($16\frac{1}{2}$ in.) in diameter and the low-pressure 640 mm. ($25\frac{3}{16}$ in.) in diameter, the stroke in both cases being 650 mm. ($25\frac{9}{16}$ in.). The high-pressure cylinders are outside the frames, and the connecting rods drive on to the second coupled axle, as will be seen from the photograph reproduced in Fig. 3, page 78. These cylinders are provided with piston valves and with a "by-pass" which is actuated by pneumatic gear coupled to the regulator handle.

The low-pressure cylinders are inside the frames and their connecting rods drive on to the front coupled axle. The valves of the high-pressure cylinders are of the piston type, whilst those of the low-pressure cylinders are flat slides. In the case of the low-pressure cylinders also intercepting valves, actuated by hand-operated pneumatic gear, are provided to allow of the low-pressure cylinders being worked at low speeds with high-pressure steam. The valve gear of both the high and low-pressure cylinders is of the Walschaert type.

The dimensions of the coupled and other wheels are shown on Fig. 1, which also gives particulars of the wheel base. The bearings of the coupled axles are 220 mm. (8.66 in.) in diameter, the length being 235 mm. (9.25 in.) in the case of the front axle and 240 mm. (9.45 in.) in the case of the second and third axles. The high-pressure crank-pins have bearings 130 mm. (5.11 in.) in diameter by 140 mm. (5.51 in.) long, while the cranks of the crank-axle on which the low-pressure pistons act have bearings 230 mm. (9.05 in.) in diameter with a length of 140 mm. (5.51 in.).

The boiler has a barrel 1,760 mm. (5 ft. $9\frac{1}{4}$ in.) in diameter outside at the back ring, while the length between tube-plates is 5,900 mm. (19 ft. $4\frac{1}{4}$ in.). The fire-box shell is 3,100 mm. (10 ft. 2 in.) long at the bottom, 1,205 mm. (3 ft. $11\frac{3}{8}$ in.) wide at the front end, where it has to pass between the frames, and 2,100 mm. (6 ft. $10\frac{5}{8}$ in.) at the back. The photographs reproduced on page 78 show this feature. The roof of the fire-box shell is of the "round-top" pattern, and is directly stayed to the crown of the inside fire-box by screwed stays. The inner fire-box is of copper and the stays are also of copper, except above the firebrick arch, where they are of a manganese alloy. The boiler tubes are of solid drawn steel and the fire-grate is of the finger-bar or rocking-bar type, and is made with a drop section at the front end. The engine is fitted with a Schmidt superheater which has 24 elements and is fitted with a "fournier" pyrometer. The particulars of the heating and grate surfaces are as follow :—

	Square Metres.	Square Feet.
Heating surface of small tubes	140	1,507
,, ,, large tubes	55.6	598
,, ,, fire-box ...	16.4	177
Total	212.0	2,282
Superheating surface (outside)	63.4	683
Total	275.4	2,965
Area of fire-grate	4.2	45.9

The general fittings of the engine include Lethuiller-Pinel safety valves, Detroit sight-feed lubricator and Flaman speed indicators. The front and hind coupled wheels are fitted with a Leach pneumatic sander, while a hand sander is provided for the centre pair of coupled wheels. A train-heating apparatus of the combined steam and compressed air type is also fitted.

The buffing gear between the engine and tender is of the Roy type, this being also used in the case of the goods locomotive next to be described. The features are well shown in the view of tender given in Fig. 9, on page 79.

The diameters of the various wheels are given on Fig. 1, annexed. The bearing springs are under-hung, and compensating beams are provided between the coupled axles and between the hind axle and the trailing truck. The general design of the tender will be seen from Fig. 3, page 78. It has a tank capacity of 22 cub. metres (4,840 gallons) and carries 5.9 tonnes (5 tons 18 cwt.) of coal. The weights of the engine and tender in working order are as follow :—

	Kilos.	Tons.	Cwt.	Qrs.
Total weight of engine in working order ...	96,550	95	0	2
Total weight of tender in working order ...	52,504	51	13	2
Total weight of engine and tender	149,054	146	14	0

With an effective pressure per square inch on the pistons equal to 50 per cent. of the boiler pressure, the engine can exert a tractive force of 9,416 kilos., or 20,760 lb. The boiler pressure is 227 per sq. in.

The goods locomotive illustrated by Fig. 2 on the present page, and Figs. 7 to 10 on page 79, is a non-compound two-cylindered engine of the Consolidation or 2-8-0 type (1-4-0 by French notation), having outside cylinders 590 mm. ($23\frac{1}{4}$ in.) in diameter by 650 mm. ($25\frac{9}{16}$ in.) stroke, the connecting rods being coupled to the third pair of coupled wheels. The cylinders are fitted with piston valves and are also provided with a by-pass which is operated by a pneumatic cylinder and directly controlled by the regulator. The piston rods and tail rods are fitted with United States air-cooled packings, and the valve gear is, as in the passenger engines, of the Walschaert type.

The dimensions of the wheels and the particulars of the wheel-base are given in the dimensions on Fig. 2. The truck is of the Zara type, already described in our pages,* the framing or cradle being pivoted at its rear end on the transverse bearing spring of the leading coupled axle. The weight carried by the truck is taken by swing links on the cradle at a point between the leading coupled axle and the truck axle, the effect being that a lateral movement of 11 mm. (0.43 in.) is allowed in each direction to the leading pair of coupled wheels. The bearing springs of the truck are arranged above the axle-boxes, as is also the transverse spring of the leading coupled axle already referred

* See ENGINEERING, vol. xcix., page 432.

EXPRESS PASSENGER LOCOMOTIVE FOR THE FRENCH STATE RAILWAYS.

CONSTRUCTED BY THE NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED, GLASGOW.

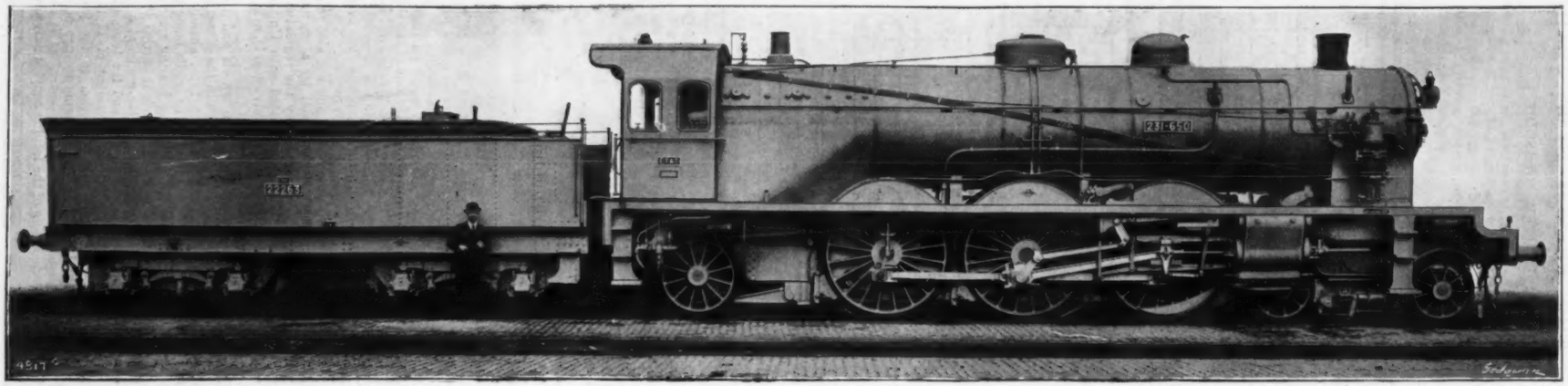


FIG. 3.

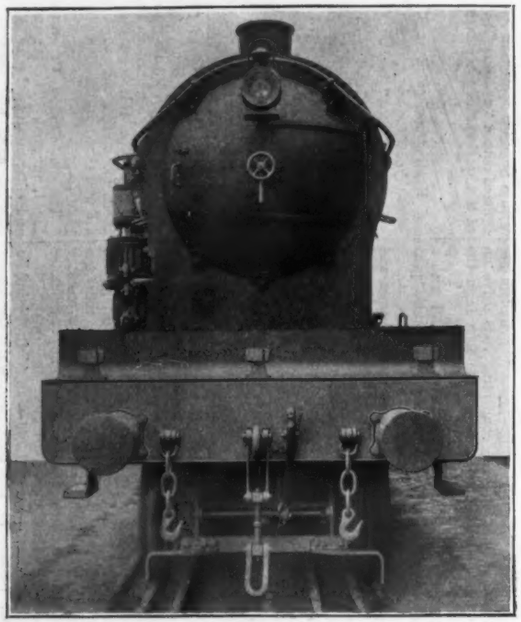


FIG. 4.

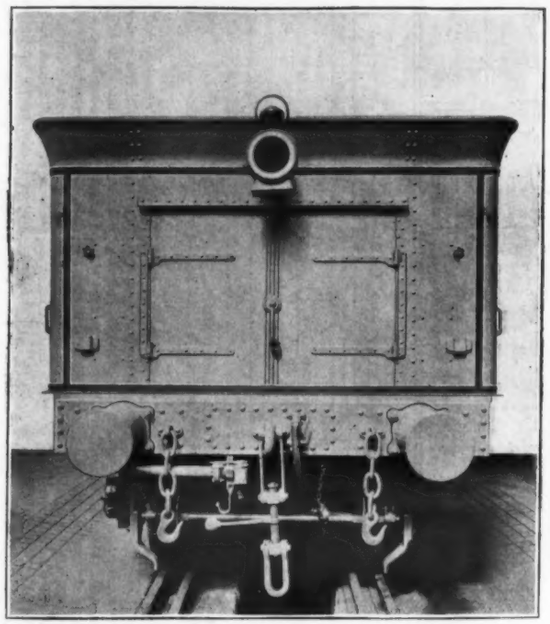


FIG. 5.

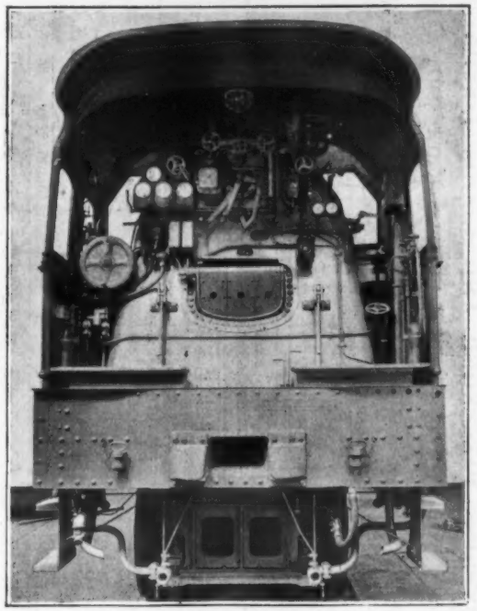


FIG. 6.

GOODS LOCOMOTIVE FOR THE FRENCH STATE RAILWAYS.

CONSTRUCTED BY THE NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED, GLASGOW.

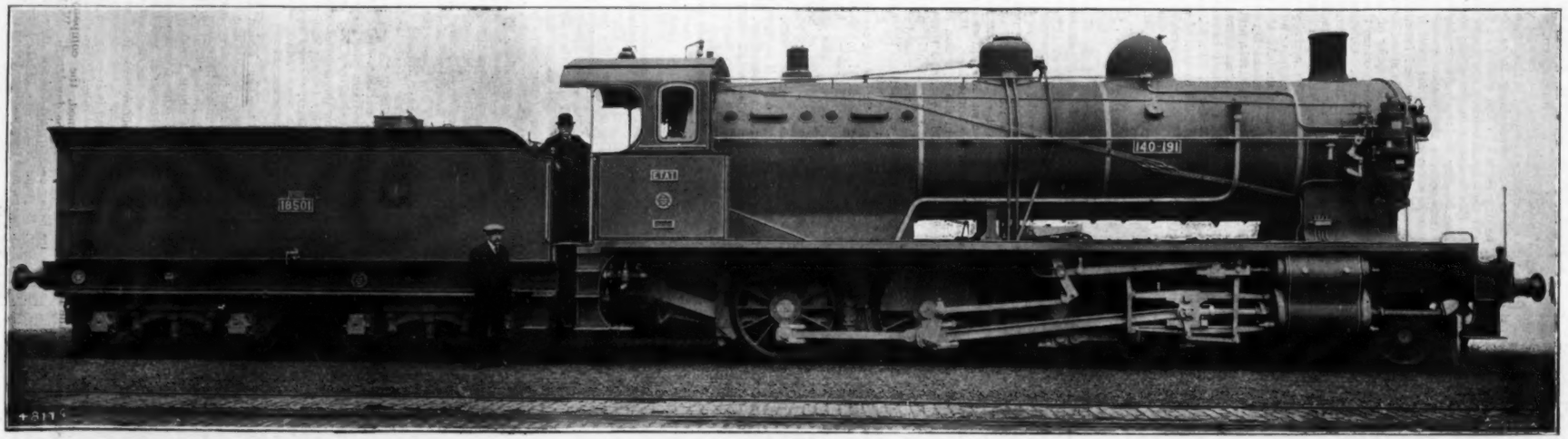


FIG. 7.

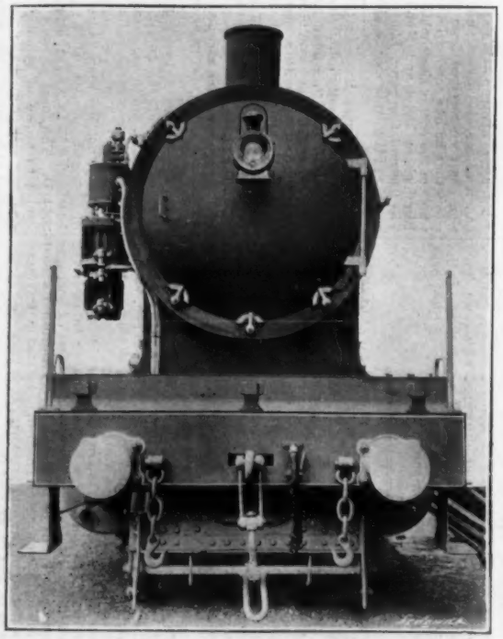


FIG. 8.

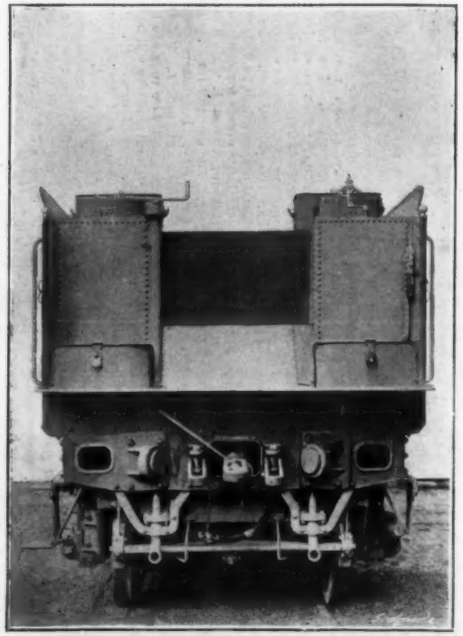


FIG. 9.

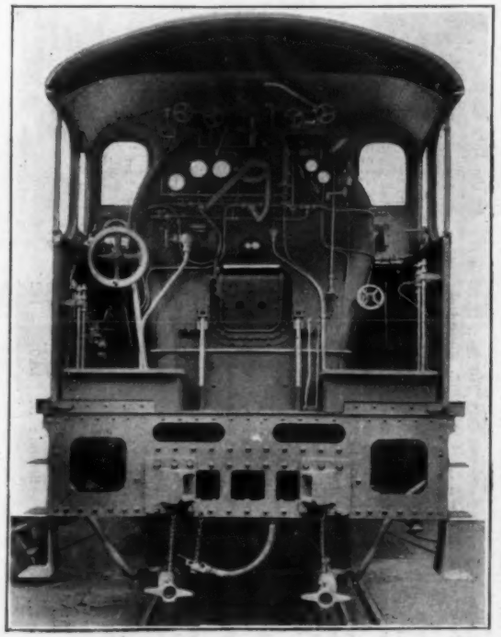


FIG. 10.

to. The remaining bearing springs are under-hung, and are compensated throughout.

The coupled axles have bearings 210 mm. (8.26 in.) in diameter by 250 mm. (9.84 in.) long, while the bearings of the truck axle are 145 mm. (5.7 in.) in diameter by 260 mm. (10.23 in.) long. The axle boxes are fitted with "Perfection" packing, which is a mixture of woollen waste, hair, and asbestos steeped in oil. The main crank-pin bearings are 145 mm. (5.7 in.) in diameter by 170 mm. (6.69 in.) long.

The boiler has a barrel 1,714 mm. (5 ft. 7¾ in.) diameter inside at the front end, and 4,500 mm. (14 ft. 9½ in.) long between tube plates. The fire-box shell is 3,300 mm. (10 ft. 10 in.) long outside at the bottom by 1,200 mm. (3 ft. 11¼ in.) wide. As in the case of the passenger engine, the fire-box shell is of the "round top" type, the inside fire-box is of copper, and the tubes are of steel, solid drawn. The boiler is fitted with the Robinson superheater, of which we have already published a full description. The safety valves are of the same type as on the passenger engine, and the boiler is fed by two No. 10 Friedmann injectors. The particulars of the heating and grate surface are as follow :—

	Square Metres.	Square Feet.
Heating surface of small tubes	110.69	1,191
" " large tubes	42.41	456
" " fire-box ...	16.9	182
Total	170.0	1,829
Heating surface of superheater (outside)	36.6	394
Total	206.6	2,223
Area of fire-grate	3.16	34

For sanding at the front of the leading coupled wheels and the back of driving wheels, a Leach pneumatic sander is fitted, while a hand sander with screw feed is provided, delivering in front of the drivers. The train heating apparatus is similar to that fitted to the passenger engine.

The weights on the various axles are given in the diagram, Fig. 2, on page 77, while the total weights are as follow :—

	Kilos.	Tons.	Cwt.
Total weight of engine in working order ...	75,035	73	17
Total weight of tender in working order ...	45,011	44	6
Total weight of engine and tender	120,046	118	3

The tender carries 5 tonnes (4 tons 18 cwt.) of coal and 18 cub. m. (3,960 gallons) of water. Its general design is shown by Fig. 7, on page 79, while Fig. 9, on the same page, gives an end view. The goods engines are capable of exerting a tractive force of 14,125 kilos (31,140 lb.) when working with a mean effective pressure on the pistons equal to 75 per cent. of the boiler pressure. The boiler pressure in the case of the goods engines is 170 lb. per square inch.

Both the passenger and goods engines are fitted with the Westinghouse high-pressure brake ; this brake, in the case of the goods engines, acting on both the coupled and the truck wheels. The air compressing pumps are of the Fives-Lille two-step type. We may add that the gauge of the French State Railways is 1,440 mm., or 4 ft. 8.6 in.

The engines we have been describing have been constructed in accordance with the specifications and detail drawings supplied by the department of Matériel et Traction of the French State Railways, and they form interesting examples of modern French practice. For the photographs and drawings which we have reproduced, and for the general particulars of the engines, we are indebted to the courtesy of the North British Locomotive Company, Ltd.

PERSONAL.—The Executive Committee of the City and Guilds of London Institute have appointed Mr. W. Eccles, D.Sc., A.R.C.S., M.I.E.E., to the Professoraip of Electrical Engineering and Applied Physics at the Institute's Technical College, Finsbury, rendered vacant by the recent death of the late Professor Silvanus P. Thompson, F.R.S. Mr. Eccles is at present University Reader of Graphics at University College, and is the author of a work on "Wireless Telegraphy and Telephony," and numerous papers and inventions on subjects connected with electrical engineering.

THE HOLIDAYS.—We have received from Mr. Walter Hill, 67 to 71, Southampton-row, W.C., a book, entitled "The Holidays, Where to Stay and What to See," which contains illustrated guides to towns and places on the Midland, the London and North-Western, Great Northern Great Eastern, Great Western and Great Central Railway systems. The guides are bound together to form the book in question. They give the addresses of boarding houses and hotels in practically every township served by the six railway systems named, or located in proximity to a station of the said systems. It is published at the rate of 1*s.* and 1*s.* 6*d.* post free.

DIESEL ENGINE-USERS' ASSOCIATION.

AT the July meeting of the Association, after some new members had been elected, questions in connection with the use of tar oils as fuel in Diesel engines were further discussed.

Mr. Napier Prentice (Felixstowe) gave his experience in regard to the use of tar oil which he had obtained from a local distiller. He had found difficulty in obtaining quotations and in getting the work in hand of altering a Diesel engine so as specially to adapt it for the use of tar oil in the manner which had been successfully employed on the Continent, and he therefore decided to try the effect of using tar oil in one engine without any alteration. At about half-load he found this was not successful as mis-firing and a smoky exhaust occurred. He was advised to work with a sharp edge on the flame plate, and with this alteration and a slightly different quality of tar oil he obtained satisfactory results so long as the engine was not run below about three-quarters of full load. The blast pressure at all running loads was maintained at five atmospheres below the normal pressure used when running with petroleum fuel oil, and the cooling water outlet was restricted so as to maintain a temperature of 125 deg. F., as against 110 deg. F., which had been maintained when using the other class of fuel oil.

Mr. F. Banks Warner gave some information as to the general position in regard to the question of obtaining suitable supplies of tar oils, including delivery on site. At the present time the high railway rates for this class of business were a serious handicap to its development in certain parts of the country where local supplies were not available.

Mr. P. H. Smith read a paper on "Crankshaft Breakages in Diesel Engines." He attributed practically all cases of shaft fractures to a lack of alignment of the main bearings, due to wear, or to negligence during erection, or to defective foundations. He stated his views as to the best method of re-bedding a crankshaft and of securing perfect alignment, and as to the best proportions in the design of crankshafts for Diesel engines.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, July 12.

AFTER a short lull in European demand a rush of orders has set in from many leading European countries. This reviving demand has been something of a surprise, and the magnitude of the incoming inquiries will undoubtedly absorb the maximum production for an indefinite period. The American navy will take at least 200,000 tons of steel for next year's ships. The aggregate of inquiries and orders in the Pittsburg district for the next 12 months will equal in value very much more than 100,000,000 dols. The Japanese Government has placed orders worth 28,000,000 dols., the British Government large orders for machinery. A new plate mill will start up, August 1, with a capacity of 75,000 tons per year. The demand for steel bars continues far in excess of capacity. Purchasers are insisting on most prompt execution of orders. Billets and bars have again advanced and wire rods are not to be had at any price. Tin plate mill capacity will be turned over to Government requirements if necessary. Railroad buying continues light. Pig-iron for steel purposes for export is again in very active demand. The Government has purchased 15,000 tons of ferro-manganese. The Carnegie Steel Company will make the steel for five large lake boats. During the past financial year the seaboard yards built 35 large steel merchant steamers. The shipbuilding industry is unable to consider many shipbuilding propositions. Before the close of the week 50,000 tons of Bessemer and open-hearth billets will be under contract for export ; prices are hardening. The oversold condition of mills is becoming more acute. Prices are creeping upwards where special deliveries are sought. The entire industrial situation is highly satisfactory. Very much domestic business is being held back in the hope of a favourable downward turn in prices.

THERMIT, LIMITED.—We are informed by the director and manager of Thermit, Limited, that a communication has been received from the Public Trustee to the effect that he has entered into an agreement to sell the whole of the enemy shareholding in that company to the Birmingham Metal and Munitions Company, Limited. The Thermit Company, Limited, will continue to trade exactly in the same way as hitherto.

THE PICTORIAL RUSSIAN COURSE.—A booklet under the above title, by S. J. Luboff, is published at 2*s.* by Leopold B. Hill, 2, Langham-place, W. It is divided into 30 lessons, each lesson being accompanied by 30 full-page illustrations, with references, conversations and a simplified grammar. The booklet will prove a help to students of the Russian language, in that it will enable them to learn a number of words and colloquial phrases. When they have succeeded so far satisfactorily, the fact that they have done so will encourage them to plunge deeper into the mysteries of our Ally's language.

DIESEL ENGINE SHAFTS.—In a paper read before the July meeting of the Diesel Engine-Users' Association, Mr. Philip H. Smith suggested the following dimensions for Diesel engine crankshafts, D being the diameter of the cylinder :—Tensile strength, not less than 34 tons ; ductility, not less than 25 per cent. in 2 in. ; diameter of pins and journals, 0.525 to 0.54 D ; length of main bearings, 0.75 to 0.8 D ; length of big-end pin, 0.525 to 0.54 D. Thickness of webs not less than 0.32 D, but centre to centre of cylinder made minimum possible, and any excess over the proposed length of pin and ournal to be put into the webs.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

South Yorkshire Coal Trade.—There is very little in the nature of a change to record in the house coal section. The demand is still exceedingly large for the better qualities, having regard to the season of the year, and it is believed that householders are more than usually cautious on this occasion in preparing for the winter months. The inquiry for the inferior grades is not so heavy, but this affords the gas companies the opportunity to lay in some reserves for their busier season. There is an active demand all round for manufacturing fuel and orders on hand leave little standing at the pits. For works and railways, the full supply of best hards is taken, and the collieries have to produce the maximum output to satisfy all requirements. Cobbles, nuts and slacks are also freely bought, but the general position is not very satisfactory, for the orders are almost all in excess of the production. The open market has practically nothing to offer. The activity extends to the export trade, the increased shipping available being a decided factor in the situation. At the same time there does not appear to be any relaxation in the restrictions governing the trade with neutrals, and the tonnage going away under this section is of an average character. To allied Powers there is a distinct increase. Quotations :—Best branch hand-picked, 20*s.* 6*d.* to 21*s.* 6*d.* ; Barnsley best Silkstone, 17*s.* 6*d.* to 18*s.* 6*d.* ; Derbyshire best brights, 17*s.* 6*d.* to 18*s.* 6*d.* ; Derbyshire house coal, 16*s.* to 17*s.* ; best large nuts, 15*s.* 6*d.* to 16*s.* 6*d.* ; small nuts, 15*s.* to 16*s.* ; Yorkshire hards, 16*s.* 6*d.* to 17*s.* 6*d.* ; Derbyshire hards, 16*s.* to 17*s.* ; slacks, 12*s.* to 13*s.* ; seconds, 10*s.* 6*d.* to 11*s.* 6*d.* ; smalls, 8*s.* to 9*s.* per ton at pit.

Iron and Steel.—The decision of the Government to permit an advance of 5*s.* per ton on common irons has created a good deal of surprise here, for it was considered that the matter had been definitely arranged a few weeks ago, and the old prices should remain in force. Many contracts have been fixed up on this understanding, but in the majority of cases these were subject to any probable revision of the tariff. Consumers, however, did not contemplate such a sudden and sweeping change of front on the part of the authorities. It is considered that determining factors in the situation have been the shortage and dearness of labour, and these are matters which the producers have persistently pressed before the authorities. The position with regard to hematites is unchanged at the time of writing, but there is an uneasy feeling that something in the nature of an advance in prices is now inevitable. If it should transpire, it will be a serious matter for Sheffield munition firms to preserve that economy of production which the Ministry of Munitions exhorts them to do. The great works are extensive consumers of all qualities of hematites, and especially of the dearer special brands which are used in making superior branches of armaments. Supplies of all classes are well forward and, if it were not for the anxious feeling regarding the quotations, the position could be considered the most satisfactory for many months past. There has been heavy buying of Lincolnshire and Derbyshire foundry iron, but contracts can only be placed with the proviso that they are subject to any subsequent revision of the prices tariff. The most pressing need is for basic iron. The quantity available is much below the city's requirements. The urgency of this matter has been brought to the notice of the Government, and it is anticipated that immediate efforts will be made to enlarge the production. There are several points involved, however, including the one of adapting the furnaces, and the considerable expense of lining them. The unsettling effect on the quotations of the altered common iron prices has spread to other sections of the raw material market, and also to the makers of basic billets. The latter are now reported to be negotiating for an advance. At present they could easily dispose of double the quantity they can produce, for the American makes are too dear to permit of their being worked over here economically, and the Swedish shipments are weekly becoming more scanty and dearer. Tramway rail manufacturers have received many large orders, both for local and other municipal undertakings. A notable order is that which has come the way of the Stavely Iron and Coal Company, Limited, in the form of 26,000 tons of cast-iron pipes, of the value of nearly a quarter million pounds, for the Argentine. Russian requirements of high-speed steel are again heavy, whilst France is placing orders for tools, picks, shovels, horse-shoes and steel. Canada is also a big customer for steel and steel goods. Other foreign and colonial custom includes indents for steel, files, tools, plane irons, pulleys, castings, shovels, sheep shears, cutlery and hardware.

AMERICAN SHIPBUILDING.—The Union Iron Works Company, of San Francisco, is negotiating with the City of Alameda for a water-front property upon which it proposes to erect what promises to be one of the largest shipbuilding plants in the United States. The site in question has a frontage of about 1,000 ft., and adjoins the Union Iron Works. The company proposes to expend 100,000*l.* in improvements at once if the property can be leased to it. In case the property cannot be obtained, the company's holdings at Hunter's Point will be developed. Ways for five vessels are now being planned, and in the autumn it is expected that employment will be given to 2,000 men. The Manitowac Shipbuilding and Dry Dock Company, Manitowac, Wisconsin, has launched the first of four steam fishing trawlers, which are being constructed for the Bay State Fishing Company, Boston. They are 145 ft. long over all by 22 ft. 6 in. beam, and they are fitted with engines working up to 450 h.p.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Stagnation still rules in the pig-iron market, nor is there any appearance of an improvement in the near future. Just as last week, 1,000 tons of Scotch pig-iron remain in store in Glasgow.

Scotch Steel Trade.—So far as the Scotch steel trade is concerned industrial conditions in the West are unchanged over the week, all the works continuing to be most actively engaged. In every case it would seem as if the mills were being taxed to their utmost capacity to keep pace with the demands of our own Government and those of our Allies, shipments of steel, especially to France and Italy, being particularly heavy. Consequently, of course, the entire output is being monopolised on this account, so that little business is being done in mercantile lines. The holiday question having now been permanently shelved, every effort is being put into the piling up of all sorts of material required for the winning of the war, for although some considerable dissatisfaction prevails in certain quarters, and many rumours, more or less vague, are floating about, it is quite evident that no slacking off must be permitted. Scarcity of labour and a shortage of supplies both of raw and semi-finished material are greatly hampering the movements of manufacturers just now, but there seems little chance of any improvement. Little or no change has taken place in current prices, ship-plates still being quoted 14*l.* 15*s.* to 15*l.* or thereabouts; boiler-plates, 15*l.* 10*s.* to 16*l.*; and angles, 14*l.* 2*s.* 6*d.* per ton and up.

Malleable-Iron Trade.—The malleable iron trade keeps very firm and a continuance of the steady business commented on from week to week is still one of the remarkable features of this singularly active time. Otherwise there is little of special consequence to chronicle. Orders show no falling-off and makers find increasing difficulty in putting these through, steel bars particularly being in constant request in large quantities for the purposes of the war. These are being rolled at many of the mills. For the ordinary grade of "Crown" bars, 14*l.* 2*s.* 6*d.* per ton is still quoted, while the better qualities easily bring in from 5*s.* to 7*s.* 6*d.* per ton over this rate.

Scotch Pig-Iron Trade.—Nothing could well exceed the demand for all classes of pig-iron, more especially for hematite grades, every ton of which seems to be absorbed by the local steel works engaged on munitions and Government contracts generally. So far as export is concerned in the meantime, no pig-iron is being allowed to leave the country, except such as is required for the use of the Allies. Neither is any hematite procurable for other than war purposes, it being completely out of the market unless purchased for one or other of the Allied Governments. The noticeable scarcity of foundry iron is also commented upon. Prices remain firm, a slight stiffening being apparent.

Clyde Munition Girls in France.—The small band of women munition workers who have just returned home after spending a few days within sound of the guns are particularly impressed with the urgent necessity not only for maintaining the present supplies of war materials of all classes, but for increasing these by every possible means. They were much pleased with their visit and by all they saw in the different factories over which they were shown, and now they are looking forward with much interest to a return visit to be paid to the Clyde area by a delegation of their French sisters.

NEW CIVIL LORD OF THE ADMIRALTY.—The King has been pleased to approve the appointment of the Earl of Lytton to be Civil Lord of the Admiralty in succession to the Duke of Devonshire, Governor-General Designate of Canada.

HEAT TRANSFER FROM SUPERHEATED STEAM TO PIPE WALLS.—Under this title R. Poenagen has published in a recent number of the *Mitteilungen über Forschungsarbeiten* a memoir of an experimental research on heat exchange between steam, flue gases, and pipe walls or condensers, with special reference to superheated steam. An illustrated account of the investigation also appeared in the *Zeitschrift des Vereines Deutscher Ingenieure* of January 8 and 16, 1916. The new experiments were made with an experimental seamless steam-pipe section, 3.5 m. in length, 96 or 34 mm. internal diameter, in a gas-fired superheater, further provided with an electric superheater in the pipe line, with steam pressures of 1, 3, 5, 7, 9 kg. per sq. cm., steam velocities up to 20 m. per second, and temperatures (measured at 7 points of different pipe diameters and in the pipe walls) up to 350 deg. C. For the coefficient of heat transfer in kg. calories per hour per deg. C. and sq. m. of pipe surface, the empirical formula is derived: $a = 3.29\ p^{1.082}\ w^{0.892}/d^{0.164}\ 10^{0.0017\ t_w}$, where p is the steam pressure in kg. per sq. cm., w the mean velocity of the steam in m. per second, d the pipe diameter in metres, and t_w the wall temperature. This formula holds for values up to $p = 9$, $w = 15$ and $t_w = 300$ deg. C. To secure maximum of heat transfer between media in motion, especially for the heat transfer from flue gases to steam, various recommendations are made: counter-flow is best, parallel flow worst, cross flow of intermediate value. Many short, narrow tubes are preferable to a few long, wide tubes; the velocity should be as high as possible on the side of the smaller heat-transfer coefficient, *e.g.*, in close-set superheater coils; for materials of lower coefficient thorough mixing is essential; in condensers the steam should be as free from air and water as possible; the steam-pipe surfaces should be rough, and the ribs be in the direction of the steam flow on the side of the medium with the lower heat-transfer coefficient.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

Cleveland Pig-Iron.—Firmness continues to characterise Cleveland pig-iron. The huge demand has depleted stocks, and most makers are sold as far ahead as they care to commit themselves. Buyers are again much in evidence, demand on home account being very insistent, but under existing circumstances it can be only partially met. No. 3 is very scarce and the quantity available is carefully and satisfactorily allocated by the local Distributing Committee. Definite information as to the promised increase of production is not yet obtainable, but preparations for the re-starting of idle plant are about complete, and one or two additional blast furnaces are likely to be in operation at a very early date. The fuel problem is the chief obstacle in the way of re-lighting furnaces. Deliveries under running contracts are being despatched with fair regularity, and immediate home needs are satisfactorily covered. For home use, No. 3 Cleveland pig is firm at 87*s.* 6*d.*, and that price also rules for No. 4 foundry and No. 4 forge; whilst No. 1 is 91*s.* 6*d.* Licences for export are not quite so difficult to secure as they have been and there are rumours of permits being granted for shipment of small lots to neutral countries. The export price of No. 3 is quite 97*s.* 6*d.*, and the quotation for No. 1 is round about 102*s.* 6*d.* for shipment abroad.

Stocks of Cleveland Pig-Iron.—Stocks of Cleveland pig-iron continue to fall steadily. The quantity held in the public warrant stores here now stands at 25,192 tons, composed of 24,822 tons of No. 3 quality, and 370 tons of other descriptions of iron deliverable as standard.

Hematite Iron.—The output of East Coast hematite iron is to be increased next week by the re-starting of an idle furnace. Very little hematite is purchaseable for early delivery, makers having sold their production fairly well ahead. Nos. 1, 2 and 3 remain at 122*s.* 6*d.* for home consumption and for shipment to France, and for general export mixed Nos. are quoted 140*s.* and upward.

Pig-Iron Shipments.—Shipments of pig-iron from the port of Middlesbrough are up to expectation, and under the conditions prevailing must be regarded as satisfactory. So far this month they amount to 41,110 tons, as compared with 35,160 tons to the same date last month, and 38,219 tons for the corresponding part of July last year.

Coke.—With local demand for coke heavy and likely to increase, and the present supply none too plentiful, efforts are being made to enlarge the make. Possibly some of the old beehive ovens that have been out of use for some time past may be put into operation once more. Medium kinds of blast-furnace coke readily realise the fixed maximum of 28*s.* at the ovens, and up to 30*s.* 6*d.* at the ovens is asked for qualities low in phosphorus.

Foreign Ore.—Values of foreign ore are fully maintained, notwithstanding the continued exceptionally heavy supplies that are coming in, and the fact that now considerable stocks are steadily accumulating. Unloadings at the port of Middlesbrough to date this month amount to no less than 217,034 tons. With up to 21*s.* asked f.o.b. Bilbao for 50 per cent. Rubio, the ex-ship Tees price here is quite 38*s.* on the basis of the official 17*s.* freight Bilbao-Middlesbrough, the rate at which controlled consumers continue privileged to arrange conveyance of ore, but in the ordinary way in the open market the freight from Bilbao is 19*s.*, making the ex-ship Tees quotation 40*s.* for best Rubio.

Manufactured Iron and Steel.—Government work continues to absorb the attention of manufacturers of finished iron and steel, and pressure for delivery of war material is unrelieved. The result is that with the exception of urgent shipyard requirements very little ordinary commercial business is passing. Quotations, all round, are strong, and steel ship rivets have again moved up. The following are among the principal market prices:—Common iron bars, 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; best best bars, 14*l.* 10*s.*; steel bars (no test), 14*l.* 10*s.*; iron and steel packing iron (parallel), 10*l.*; iron and steel packing iron (tapered), 12*l.* 5*s.*; iron and steel ship plates, 11*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; iron ship rivets, 17*l.* 10*s.* to 18*l.* 10*s.*; steel ship rivets, 20*l.*; steel strip, 17*l.*; steel hoops, 16*l.* 10*s.*; steel sheets (singles), 18*l.* 15*s.*; steel sheets (doubles), 19*l.*; steel railway sleepers, 12*l.*; and heavy sections of steel rails, 10*l.* 17*s.* 6*d.*

THE TIMBER AND CORK RESOURCES OF ALGERIA.—We read in *La Nature* that the woodlands belonging to the State form an area of about 1,910,000 hectares, besides the privately-owned forests. Of the total, 750,000 hectares are covered with Alep pines; over 700,000 hectares with oak; 315,000 hectares with cork-oak, the latter in some provinces forming the most important source of revenue. (One hectare = 2.470 acres.)

LOCOMOTIVE ORDERS TO THE UNITED STATES.—Locomotive orders in June, says the *Iron Age*, were the lowest this year. In the last three weeks, orders for 77 have been placed, while new inquiries are for less than 40. It is understood that the Canadian Locomotive Company has secured the Russian order for 1,000 small locomotives, and that at least a large majority of these will be sub-let to the American Locomotive Company, the Baldwin Locomotive Works, and the Lima Locomotive Corporation. It is reported that the Baldwin Locomotive Works have taken an order for 100 small locomotives for the French Government.

NOTES FROM THE SOUTH-WEST.

Cardiff.—The steam coal trade has shown some weakness. Tonnage has arrived slowly, and there have been fewer vessels in dock than for a considerable period. Outputs have at the same time been maintained at an improved level; and as the authorities have been taking reduced quantities of coal, colliery owners have found stocks increasing. Under these circumstances, ready buyers could probably obtain substantial concessions; colliery owners have, however, shown a disposition to maintain quotations for August, as it is uncertain whether miners will agree to a postponement of August holidays. Coal-owners are also hoping that requirements for coal for France will increase with the completion of arrangements under the limitation of prices and freights scheme. House coal, patent fuel and coke have shown firmness. The best Admiralty large steam coal has been to some extent nominal; secondary qualities have been making 39*s.* to 40*s.*; Monmouthshire Black Veins, 39*s.* to 40*s.*; ordinary Western Valleys, 38*s.* to 39*s.*; Eastern Valleys, 35*s.* to 37*s.*; best bunker smalls, 27*s.* to 28*s.*; and cargo smalls, 20*s.* to 22*s.* per ton. In bituminous coal, best households have brought 25*s.* to 26*s.* per ton at the pits; No. 3 Rhondda large, 44*s.* to 45*s.*; smalls, 30*s.* to 32*s.*; No. 2 Rhondda large, 35*s.* to 36*s.*; and No. 2 smalls, 22*s.* to 23*s.* per ton. The latest quotation for patent fuel has been 50*s.* to 51*s.* per ton. Special foundry coke for export has brought 62*s.* 6*d.* to 65*s.*; good foundry coke, 60*s.* to 62*s.* 6*d.*; and furnace coke, 50*s.* to 55*s.* per ton.

A Cardiff Conference.—The 19th annual conference of the Institute of Cleansing Superintendents has just been held at Cardiff, the president-elect being Mr. W. Harpur, C.E., Cardiff City Engineer. Mr. Harpur, in his presidential address, traced the material progress of Cardiff during the last 18 years, observing that few English towns could boast of a better system of drainage. In the Taff Fawr Valley, Cardiff had one of the finest watersheds in the kingdom with an abundant supply of pure soft water. The effect produced on the public health of the district by the various public works which had been constructed might be seen in the reduction which had taken place in the death rate. Mr. Harpur added that the total lengths of highways in Cardiff was now 135 miles, as compared with 32 miles in 1875. There were now also 32 miles of electric tramways in Cardiff, and the town had developed a large number of parks and open spaces.

Western Trade Matters.—At the 33rd annual general meeting of the English Crown Spelter Company, Limited, held at the offices at Port Tennant, Swansea, the accounts submitted showed a profit for the past financial year of 49,929*l.*, admitting of a dividend of 20 per cent., 8,597*l.* being at the same time carried forward. The chairman (Mr. R. Francis) said the total production for the past 12 months had been 10,131 tons, against 8,823 tons in 1914. Prospects for 1916 were considered favourable; the dressing works had given a higher percentage of extraction of concentrates. The two new furnaces contemplated at the last annual meeting were now about completed; one had, indeed, started, and the second would be ready before long; it was proposed to increase the number of the company's furnaces to 20.—Lord Rhondda has been appointed a member of a committee formed by the Government to consider the commercial and industrial policy to be adopted by the country after the conclusion of the war.—The steel steamer Corinth, built at Sunderland in 1904, and about 6,200 tons deadweight, has been sold to the Page Shipping Company, Limited, Cardiff.—The directors of the Albion Steam Coal Company, Limited, have decided to pay 1¼ years' dividend on the 6 per cent. preference shares. At the commencement of this year this preference dividend was two years in arrear. Last year four years' arrears were paid, and the company is now free to resume dividends upon its ordinary shares, which were suspended in 1908. —Mr. A. J. Griffiths, who has been sales agent at Cardiff docks for North's Navigation Collieries, has accepted an appointment with Thomas and Davey—of which Lord Rhondda is the head—sales agents for the Consolidated Cambrian, D. Davis and Sons, the Ferndale and other great coal concerns. It is understood that Mr. Griffiths will be associated more particularly with Ferndale.—The fourth annual meeting of the Status Investment Trust was held on Friday, at Cardiff, Mr. J. Davies presiding. The chairman observed that with the return of men from the war and with the great capital reserves available, he did not think there need be any fear as to the industrial future of South Wales. A dividend for 1915–16 at the rate of 15 per cent. per annum was declared.—The Atlantic Oil and Rubber Trust, Limited, has become the Atlantic Trust, Limited, and the registered office of the company has been removed from London to Cardiff.—The Standard Shipbuilding Company, of Chepstow, has acquired the undertaking of Messrs. E. Finch and Co., of the Bridge Engineering Works, Chepstow. It was a proposed extension of the Bridge Engineering Works which first led to the formation of the Standard Shipbuilding Company. A new company is to be formed to continue the business of Messrs. Finch; this new company is to be known as Edward Finch and Co. (1916), Limited.—The directors of Hill's Dry Docks and Engineering Company report a balance of 15,199*l.* available for distribution and they propose a dividend of 10 per cent., carrying forward 2,099*l.*; 16,500*l.* has been reserved under the Munitions Act. The dividends for 1915 and 1914 were at the rate of 5 per cent. per annum. The Cunard Steam-Ship Company has announced direct weekly sailings from Avonmouth Docks; the Ardgarrock is to leave for Montreal to-morrow (Saturday).

40-TON BLOCK-SETTING TITAN CRANE AT FISHGUARD HARBOUR WORKS.

CONSTRUCTED BY MESSRS. STOTHERT AND PITT, LIMITED, ENGINEERS, BATH.

(*For Description, see Page 74.*)

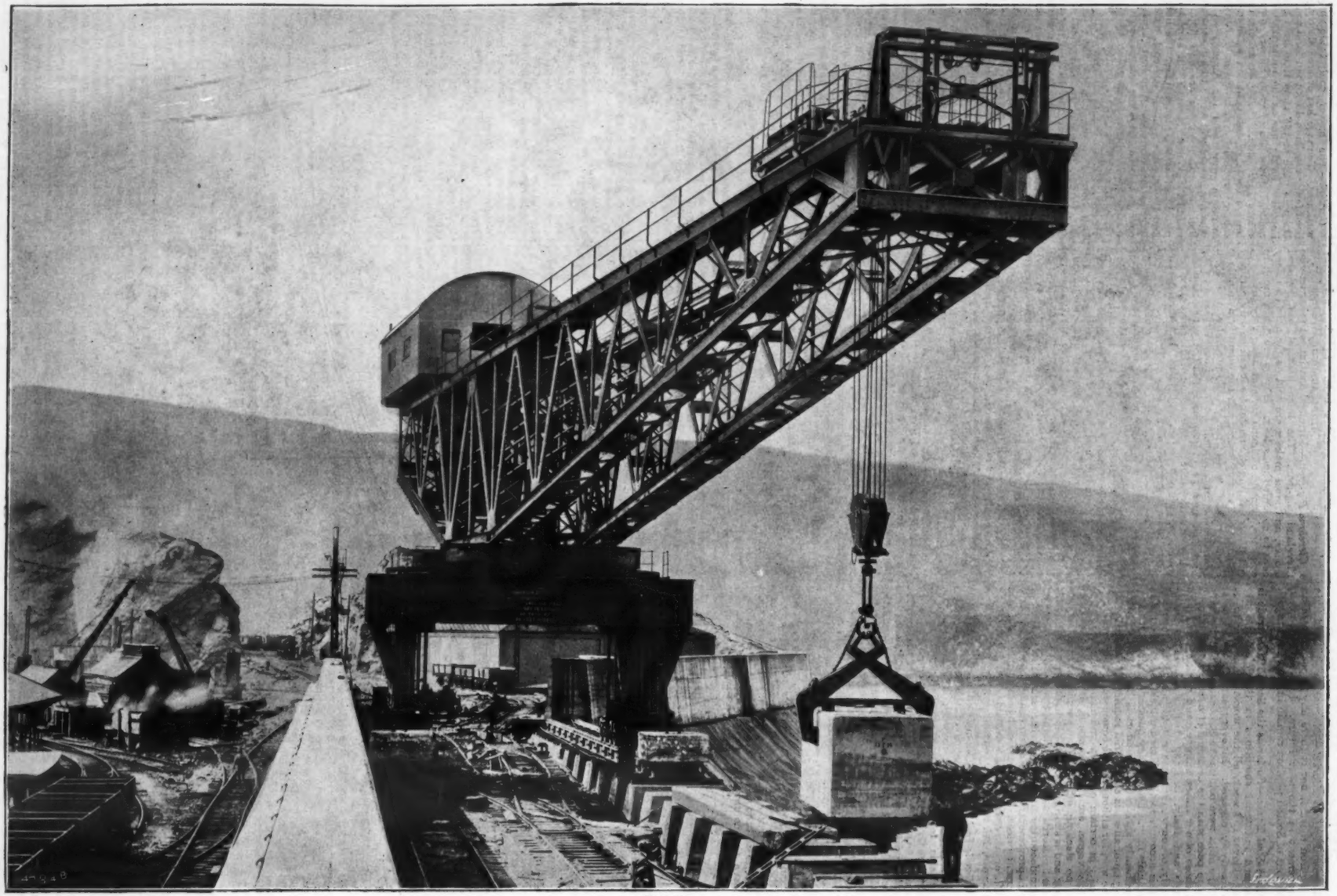


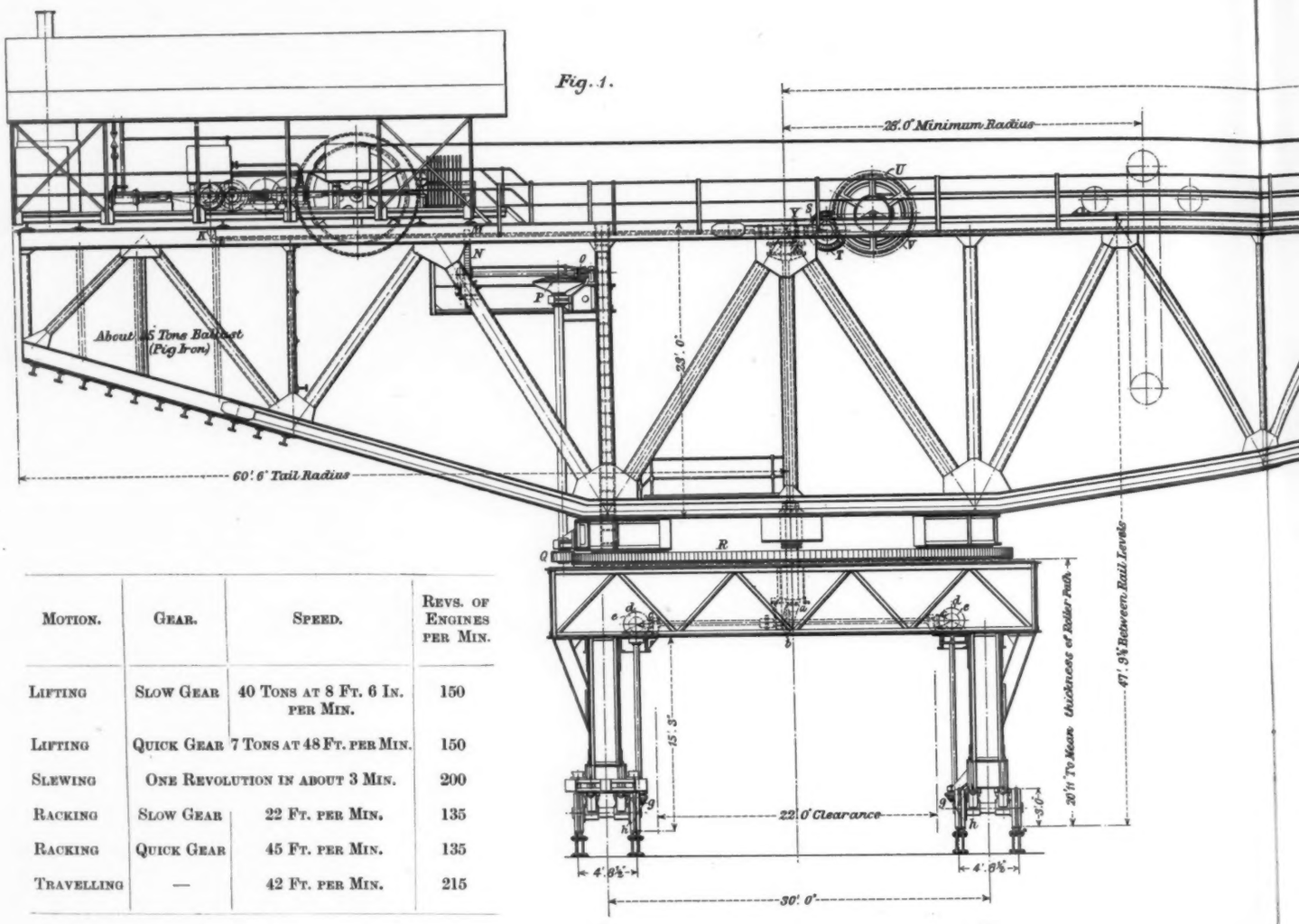
FIG. 5.

40-TON BLOCK-SETTING TITAN CRANE A

CONSTRUCTED BY MESSRS. STOTHERT AND PI

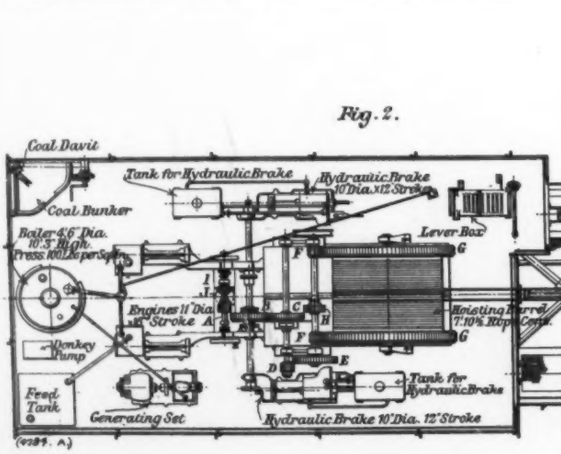
(For Descripti, see Pa

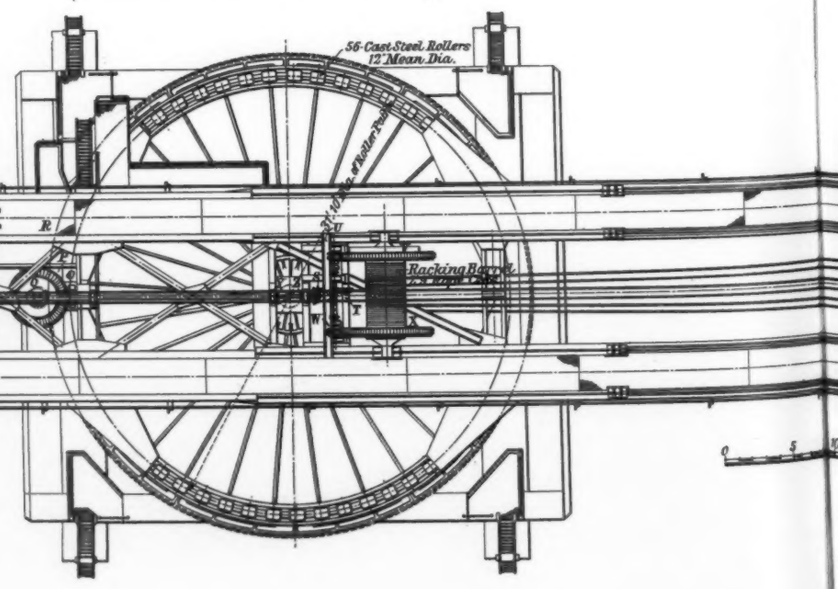
Fig. 1.



MOTION.	GEAR.	SPEED.	REVS. OF ENGINES PER MIN.
LIFTING	SLOW GEAR	40 TONS AT 8 FT. 6 IN. PER MIN.	150
LIFTING	QUICK GEAR	7 TONS AT 48 FT. PER MIN.	150
SLEWING	ONE REVOLUTION IN ABOUT 3 MIN.		200
RACKING	SLOW GEAR	22 FT. PER MIN.	135
RACKING	QUICK GEAR	45 FT. PER MIN.	135
TRAVELLING	—	42 FT. PER MIN.	215

Fig. 2.


Coal Davit
Tank for Hydraulic Brake
Hydraulic Brake 10" Dia. x 12" Stroke
Coal Bunker
Boiler 4'.6" Dia. 10'.3" High. Press. 100 Lbs. per Sq.
Lever Box
Engines 11" Dia. x 8" Stroke
Hoisting Barrel 7.10" Rope Cent.
Donkey Pump
Feed Tank
Generating Set
Tank for Hydraulic Brake
Hydraulic Brake 10" Dia. 12" Stroke



RANE AT FISHGUARD HARBOUR WORKS.

HERT AND PITT, LIMITED, ENGINEERS, BATH.

Descripti, see Page 74.)

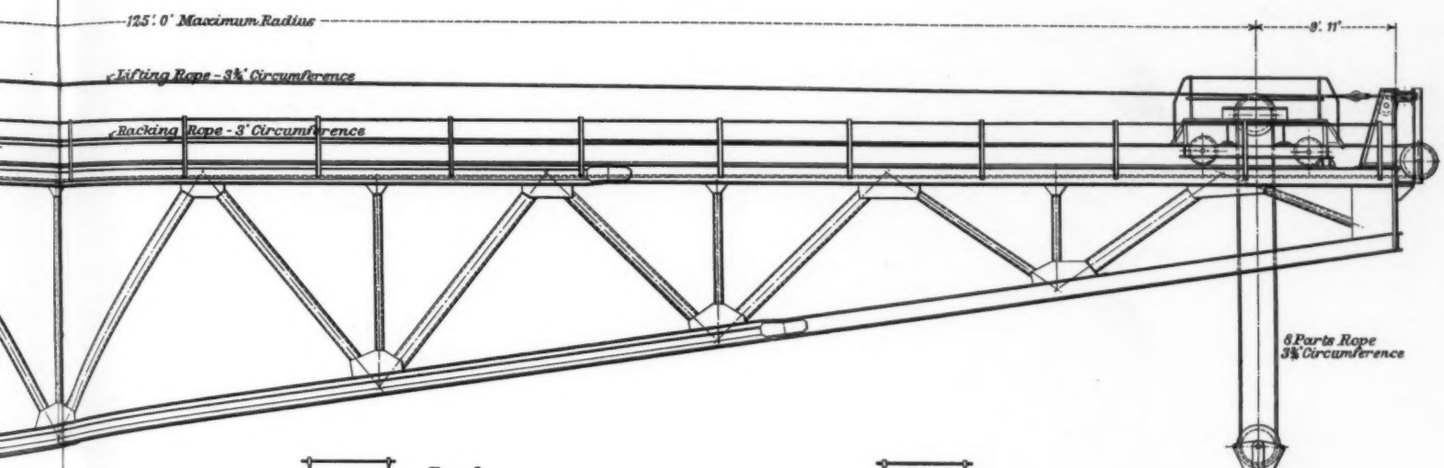
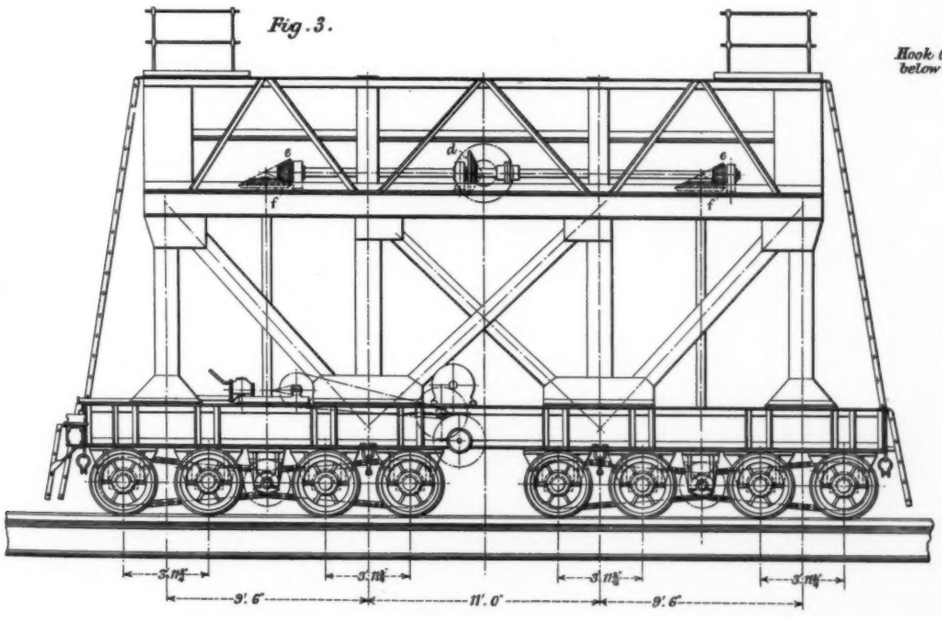
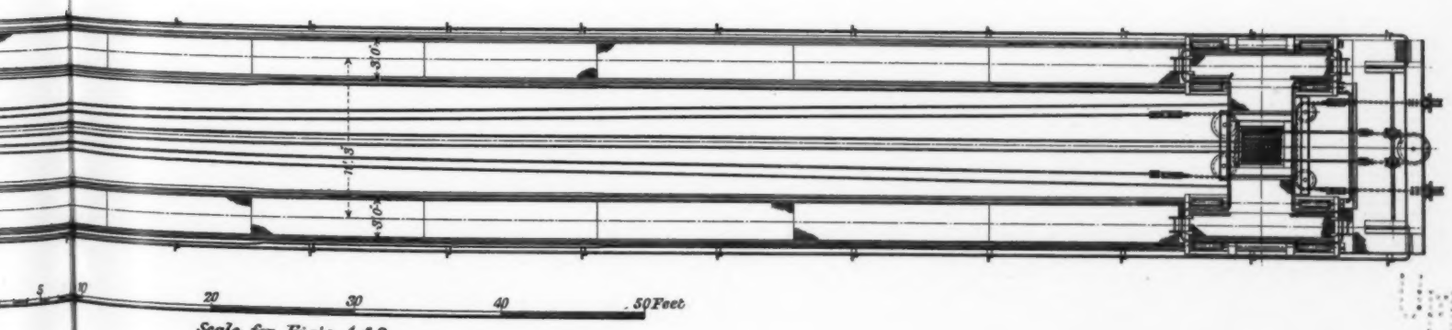

125'. 0" Maximum Radius
9'. 11"
Lifting Rope - 3¾" Circumference
Racking Rope - 3" Circumference
6 Parts Rope 3¾" Circumference
Hook to descend 80'. 0" below Rail Level
5.6" Cone fir 10'. 0" Blocks
40 Ton Concrete Block
6 ¾ Cone fir 12'. 0" x 3'. 0" Blocks

Fig. 3.





5 10 20 30 40 50 Feet

Scale for Fig's 1 & 2.

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Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

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We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—8063 and 8568 GERRARD.

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NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

ENGINEERING.

FRIDAY, JULY 28, 1916.

NAVAL EFFICIENCY.

Two years ago there was a great naval review at Spithead, to display, as far as was possible, the efficiency and preparedness for all eventualities of the British Naval Fleet. The storm which was gathering in the East of Europe at that time, and which broke with such startling suddenness and developed with such appalling force, within a week, has since put the Fleet to an unprecedented test. The temporary mobilisation of our naval force enabled us to gain the fullest advantage, strategically and tactically, from our preparedness, so far as *matériel* and *personnel* were concerned, and practically from the first day of war the Navy has fulfilled the highest expectations of the most sanguine. It is important, now that we are completing the second year of the great conflict, that there should be some reflection, not so much on the actual work done as upon the means by which great things have been achieved. We do not therefore seek to estimate the comparative losses nor to attempt to appraise the relative strength of the opposing fleets. It is enough to be able, from the knowledge we possess, but cannot disclose, to say that the British Fleet to-day is not only relatively but actually immensely stronger than at the beginning of the war.

When it becomes permissible to review the work done in the construction of new ships, it will be seen that new squadrons of capital ships and of light cruisers, many flotillas of small craft, and very many miscellaneous types of war craft, have been added to the Navy in the two years, as a consequence of the concentration of all our mental, physical and mechanical resources in shipbuilding and marine engineering, all the works being directed almost exclusively to the increasing of the efficiency of our sea force. We have lately, on the invitation of the Admiralty, had the privilege of visiting shipbuilding works and the Fleet, and on all sides there were evidences of a great advance, not only in the tactical qualities of design and construction of new ships, but in the facilities for overhaul and repair of existing ships. In the science of naval architecture Britain has led the way, alike in merchant and fighting ships; and to this traditional superiority there has been added the knowledge gained by a close analysis of the information available regarding the influence on design of modern tactics, as well as by an investigation of the effects of attack. Thus it may be accepted, without our entering into details, that the newer ships are greatly superior in every element of fighting efficiency to those of former days. Beyond this it would be imprudent to go. As to the rapidity of construction, the achievements have far surpassed those of peace time. Some of the greatest ships yet conceived have been built well within 18 months from the date when the tactical conditions to be met in design were first enunciated by the naval authorities; in normal times the period required would have been quite double. A view on one of these ships, showing the four powerful guns forward, is reproduced from an official photograph on page 86. This result in rapid construction has been got, first, by the organisation of the shipbuilding works in order to economise labour, to ensure that the maximum number of men may be employed on the ship without each getting in the other's way, and by the co-ordination of the work of different departments, so as to ensure the maximum of output in a given time. Again, in the building of smaller craft, those firms having experience have played the patriotic part of contributing readily to the needs of inexperienced although otherwise competitive firms, by guiding them in the execution of work which was entirely new to them. Many shipbuilding firms who before the war had no knowledge of Admiralty conditions are to-day turning out most satisfactory warships. This has been achieved by the interchange of valuable hints, and even by the transfer of experienced workers from one yard to another.

The maintenance of the Fleet, apart altogether from the repair of damage during naval engagements, has involved an organisation of the most intricate character. One must first realise the extent of work done by practically every ship in the fleet. The navy is a silent service; the work is continuous: reconnaissance work is always in progress; the Fleet frequently sweeps the North Sea; the ships are engaged on patrol and on the examination of merchant ships, in order to render effective the pressure on the enemy by minimising his imports. According to Vice-Admiral Bacon's latest despatch, issued on Wednesday of this week, covering a period of almost six months, 21,000 merchant and auxiliary ships passed through the Dover patrol, and of such patrols there are many. As the North Sea, from the Shetlands to Dover, is frequently storm-swept, it results that the vessels get severely handled by the forces of Nature. Thus there is a great amount of work to be done to keep the ships at their highest state of efficiency. The overhauls are frequent, the painting of the hull periodic, and the re-coaling, re-oiling and re-equipping with munitions are undertaken when necessary, and that is very frequently. Rarely—hardly ever—does the call come without the ship being fully prepared, and it is an occasion of the keenest regret to the officers and crew—as happened with the Queen Elizabeth recently—when the ship cannot respond to the call. She was in dry dock being painted.

Apart altogether from refit work or ordinary overhaul, which is more or less routine, there is the difficulty of a fleet returning from action, each ship having, to a more or less extent, suffered from the effects of gun fire or torpedo. Let it at once be said that in no case have machinery defects been disclosed. It goes without saying, however, that in such a fight as that off the Jutland coast two months ago considerable damage must be done, even to the ships of the victorious fleet. The proof of the satisfactory character of our organisation for such work is provided by the fact that within 10 days even the most seriously damaged of our ships was ready to return to the attack and that the great majority of them were ready with renewed munition and other supplies within 24 hours. This result was achieved by a completely organised system of preparedness. Before the ships reached their base there was full knowledge at the Admiralty as to the extent of damage done, and exact information, for instance, of plates to be renewed either in hull, funnel or superstructure, and of new parts of machinery to be replaced. Indeed, the work of producing the plates and of getting new units of machinery was in progress before the ship reached her base or the private establishment to which she was signalled to proceed. In our visit to one of the bases we had convincing evidence of the rapidity with which the repair work was carried out. It may be hinted here that the oxy-acetylene process for cutting plates and for welding has proved of wonderful utility.

A visit to the ships of the Fleet and conversation with the officers reveals the remarkably confident spirit that prevails in every rank. In the engineering branch, which has immense responsibility in ensuring one of the most important tactical advantages—high-speed—great work has been done. The engineering officers during the engagement could not leave their stations, they worked continuously, and the chief had to rely on the telephone to ensure that all was well in the stokeholds and other machinery compartments. They could hear the crash of their own guns discharging, but to the ever-possible prospect of the enemy's shot piercing the ship they paid little heed. The sensation of a shell striking the ship in many cases corresponded to that of a blow of a heavy sea, and this latter solacing idea was accepted unless there was evidence to the contrary. Many of the ships came out of the engagement practically without a scratch, although they themselves had done terrible execution, and in none of the ships that remained afloat was there any serious damage to the machinery. The funnels seem to have been a

favourite target, and in one or two cases steam-pipes were "disturbed." In other instances a heavy burden was cast on the turbines, particularly in the case of the Warspite, because of the steering machinery being put out of action; but this ship, which the Germans claimed to have sunk, steamed back to her destination at 21 knots speed, the turbines being used also for manœuvring instead of the rudder, and it is to the highest credit of the executive and engineering officers that they were able to out-manœuvre the torpedo attack to which they were subjected. As proof again of the efficiency of preparation for such cases, there is the fact that within a quarter of an hour of passing over the sill of the graving dock she was high and dry on the keel blocks of the dock, and repair work commenced. She has been ready for some time again to engage with the enemy, and waiting for the opportunity to arrive. Indeed, this applies to all of the ships, and it is hoped that in some of the periodic sweeping operations in the North Sea they may again have the chance of coming up with the German fleet, and, further, that climatic conditions will be normal and give both sides a fair chance for a fight to a finish. To quote a now historical expression, "Britain may sleep comfortably in her bed." All is well with the Navy.

WOMEN RAILWAY EMPLOYEES.

MANY thousands of women are now being employed on the railways in grades formerly wholly occupied by men. At all large stations there are women ticket collectors, while the majority of the carriage-cleaning is performed by women. There are also women porters, weighbridge attendants, timekeepers, restaurant car attendants, engine cleaners, &c., and certain of the smaller stations are in charge of women. In view of the number of such employees, it will occasion no surprise that the National Union of Railwaymen should have taken steps, in common with other trade unions, to enrol this new class of worker, and last year the rules of the National Union were altered so as to admit women employees. At the same time the Union made representations having for their object the safeguarding of the trade-union principle commonly known as the "price of the job." We believe that at the time these representations were made the majority of the railways were paying women employees some 3*s.* or 4*s.* per week less than the men whose places they had taken. This was regarded as justifiable for the reason that the women had not received any preliminary training, whereas, for example, men ticket collectors are ordinarily appointed from the grade of porter, and are, therefore, qualified to discharge other work than that of ticket-collecting. The object the National Union had in view was made clear by a statement of the President of that Union at the Conference of his Society in June last year, when he said:—"I will only say that we view the employment of women at less rates than those paid to men in positions where the rates have been the subject of agreements as highly prejudicial, and the protection of the standard wages for these positions is a principle to which, I hope, we shall tenaciously cling." The upshot of this was that meetings were held between a Committee of Railway General Managers and representatives of the Trade Union, at which an assurance was asked for, and given, that the employment of women in capacities in which they had not formerly been employed was an emergency provision arising out of the circumstances created by the war, and would not prejudice in any way any undertaking given by the companies as to the re-employment of men who had joined the colours on the conclusion of the war. It was also agreed that the employment of women during the war in capacities in which they had not been previously employed was an emergency provision arising entirely out of the war, and was without prejudice to the general question of the employment of women. As regards pay, it was laid down that, for the duration of the war, the pay of women employed in grades in which they were not employed prior to August, 1914, shall be the minimum pay of the grade.

Notwithstanding this very definite agreement, we understand that an application was recently put forward for a war bonus to be paid to the women in addition to the minimum pay of the grade in which they are employed. This was not acceded to and, presumably as a test case, the application made to the Great Western Railway was recently submitted to the Committee on Production for their decision. Representatives of the parties were heard on July 10, when the Union advanced the claim that the female employees should be paid a war bonus of 5*s.* per week, or the same amount which is paid by the railway companies generally to their male employees. The company claimed that in August, 1915, they arranged with the National Union of Railwaymen to grant considerable increases of wages to the women, and at the same time agreed that for the duration of the war the pay should be the minimum of the grade, in accordance with the terms of the understanding to which we have already referred. The Committee on Production, having given consideration to the statements and arguments submitted to them, have found that the claim of the Union for the payment of a war bonus to the women employees has not been established. We understand that this decision is regarded in railway circles as of very great importance.

THE LATE SIR WILLIAM RAMSAY, F.R.S.

WHEN Sir William Ramsay retired in 1913, not yet 61 years of age, it was with the intention of devoting himself to private research, untrammelled by official duties. He continued to work hard, as he always had done, but he was not long spared. Illness, symptoms of which appeared last autumn, undermined his strength, and he succumbed on Sunday morning, July 23, in his house, Hazlemere, at High Wycombe. With him has passed away one of the most popular figures among modern chemists. For the public his fame rests on his discovery of the rare gases and on his experiments on apparent transmutations of the elements. The former discovery might, by his colleagues, be regarded as a fortunate incident, if it had not been the result of long-continued systematic researches of exquisite exactness, which entitle him to the highest respect; the alleged transmutations remain unconfirmed and questionable. Chemists will chiefly remember his work on physical chemistry, on molecular physics, specific heats, critical points, boiling points, &c., work which embraced also the discovery of the rare gases. His many pupils will cherish the memory of their teacher.

William Ramsay was born in Glasgow, on October 2, 1852. He descended from a race of chemists, and his only son, of the same Christian name—his father was also named William—is carrying on the traditional chemical work of the Ramsays of seven generations. There is another Sir William Ramsay, also a Glasgow man and a distinguished scholar, Sir William Mitchell Ramsay, late Professor of Humanity at Aberdeen University, and there is, or was, a William Ramsay, Professor of Geology at Helsingfors. They belong to other families, we believe; but the late Sir Andrew Crombie Ramsay, for some time Director of Geological Survey in London, was the chemist's uncle. William Ramsay's grandfather, a manufacturer, was President of the Glasgow Chemical Society a hundred years ago. Ramsay was educated in Glasgow; in his nineteenth year he went to Heidelberg and then to Tübingen, to study chemistry under Bunsen and under Fittig. Returned to Glasgow in 1872, he became assistant at Anderson's College, teaching also at the University. In 1880 he was appointed Professor of Chemistry at University College, Bristol, at which he became Principal a year later, before he was 30 years old; he held the two appointments until 1887, when he became the successor of Thomas Graham and Alexander Williamson in the chair of chemistry at University College. He retired 26 years later, in 1913.

His dissertation-research at Tübingen had been on orthotoluylic acid, and his early work concerned chiefly organic chemistry. He also contributed papers to the Chemical Societies of London and Berlin, to the Royal Society, &c., on hydrogen persulphide, natural bismuth sulphides, the Grove battery, occlusion of gases, the atomic weight of boron, &c. But special domains of physical chemistry attracted him most, and he devised many apparatus for the investigation of the molecular volumes of phosphorus and sodium vapour and similar problems. He was probably the first who suggested, in 1879, that the Brownian movements of small particles suspended in liquids were due to a bombardment of the particles by the molecules of the liquid; the suggestion was independently made later by Gouy, to whom it is mostly ascribed. Three years earlier Ramsay contributed a paper to the Geological Society in which he pointed out that the salt of sea water helped to coagulate and to precipitate the fine mud particles carried by rivers; but he did not further experiment on the precipitation of colloids by electrolytes, nor on colloids in general.

As regards the gas law $p\,v = \mathrm{R\,T}$, and the work of Andrews and James Thomson on "Continuity of State," Van der Waals had given in 1873 the modified formula $\left(p + \frac{a}{v^2}\right)(v-b) = \mathrm{R\,T}$, in which a concerns the attractive forces between molecules, and b the small volume taken up by the molecules themselves in the big volume of a gas. Ramsay and Sydney Young (now Professor in Dublin) in 1887 wrote the equation of state in the form $p = \mathrm{RT}-c$, which covers the general case, provided the volume of the system be kept constant. Comparing two closely allied substances (*e.g.*, the methyl and ethyl acetates) under equal pressures, Ramsay and Young had already found that the ratio of the absolute boiling points of the two substances always gave the same value when determined at different pressures, so that $\mathrm{T_A}/\mathrm{T_B} = \mathrm{T'_A}/\mathrm{T'_B}$. As regards polymerisation or association of molecules and dissociation, Eötvös had, in 1885, based a formula for the temperature co-efficient of the molecular surface energy of a liquid (depending upon the molecular weight, specific volume and surface tension of the liquid) on a consideration of "corresponding states." Although differing from Eötvös as to his constant, Ramsay and John Shields in 1893 deduced from these considerations a method for allowing for association and dissociation in vapour density determinations; the method has been much used, though it is admittedly, like others, open to objections. Liquid water, for instance, probably consists mainly of dihydrol $(\mathrm{H_2O})_2$ ice chiefly of trihydrol $(\mathrm{H_2O})_3$.

The discovery of a "New Gaseous Constituent of our Atmosphere" was communicated to the Chemical Section of the British Association Meeting at Oxford in 1894, in a joint paper by Lord Rayleigh and Professor Ramsay. The fact that the nitrogen isolated from air was denser (by $\frac{1}{2}$ per cent. sometimes) than chemically-prepared nitrogen had struck Rayleigh, who destroyed the nitrogen of a mixture of air and oxygen by long-continued sparking in the presence of alkali (to absorb the nitrous gases formed) and then absorbed the oxygen by pyrogallol. This was Cavendish's method; Ramsay absorbed the oxygen and bound the nitrogen by magnesium, a more satisfactory method. The inert constituent remaining unaffected by these reactions was afterwards named argon. Examining then the gases given off by various minerals for argon, and possible other new gases, Ramsay discovered helium (already known spectroscopically to astronomers) especially in uranium ores. The further search, conducted in conjunction with Morris W. Travers, led him to suspect an undiscovered gas—the subject of his address to the Chemical Section of the Toronto meeting, 1897—intermediate in atomic weight between helium (4) and argon (40), on the analogy of Döbereiner's trials (groups of three similar elements), and he found neon, and subsequently xenon and krypton.

As regards radioactivity, it may be useful to point out that radioactivity was discovered by Henri Becquerel, and radium by Professor and Mme. Curie. The theory of the disintegration of radium is due to Rutherford and Soddy, and Ramsay and Soddy discovered in 1903 that the α particles emitted by radium and its emanation (isolated by Rutherford and Soddy) turn into helium gas when deprived of their electric charge. The emanation (itself a gas) was granted the rank of an international element a few years ago under the name of niton, which Ramsay had introduced. He had been studying this emanation, whose atomic

weight he finally settled at 222.4 (radium 226.4) in conjunction with R. Whytlaw Gray, by the aid of a new micro-balance (a modification of the balance of Steele and Grant). Later, in 1912, they also redetermined the atomic weight of radium. The study of the chemical action of radium emanation led to sensational results, which were communicated to the Chemical Society in 1908 and following years. In conjunction with A. T. Cameron, Ramsay observed that water was decomposed by the emanation and that neon and helium were found in the resulting gas, whilst emanation alone degraded merely into helium; that in the further presence of salts of elements of higher atomic weights (copper) the degradation led to the formation of argon, itself an element of higher atomic weight; and that in the last-mentioned case minute traces of copper were transformed into lithium. The transformation of emanation (in the presence of water) into neon was claimed as the first conclusive case of a transmutation.

It was also stated by Ramsay and F. L. Usher that under the influence of radium emanation the higher elements of the carbon group (silicon, titanium, zirconium, &c.), broke down, and that their salts yielded carbon dioxide. Ramsay was President of the Chemical Society (in 1908 and 1909) when these claims were made. They were severely criticised, and it must be admitted that Ramsay's work had always found critics—naturally enough, considering its novelty—and that some of his collaborators later turned into critics and opponents. Hartley pointed out that traces of lithium were almost unavoidable, in particular wherever dust (including cigarette smoke), glass, and copper occur; Mme. Curie altogether failed to confirm any of the results in most painstaking experiments, and the transmutations never received any confirmation; neither of the experimenters published further data. The suggestion of transmutation was renewed, directly by Ramsay in 1912 and 1913, when he found helium in old X-ray tubes, and indirectly—the experimenters merely recorded their observations—by J. N. Collie and H. S. Patterson, who (working independently at first, also at University College) passed the electric discharge for long periods through hydrogen, or bombarded fluorite with cathode rays in hydrogen and then discovered helium and neon in the gas; the evidence was in all these cases merely spectroscopic. These new observations gave rise to a heated controversy, into which the name of J. J. Thomson was drawn without justification; but we think that at present most scientists accept the refutation of these statements by the independent experiments of C. G. Egerton, T. R. Merton, and R. J. Strutt.

The other later work of Ramsay concerns the mineral waters at Bath (investigated together with J. Orme Masson). He also delivered the Moissan Memorial Lecture before the Chemical Society in 1912. His last paper was received by the Royal Society in April and published in the Proceedings of the Society of July 1, 1916. It bore the title "A Hypothesis of Molecular Configuration in Three Dimensions of Space," and went back to a suggestion which Ramsay had made in his presidential address to the Chemical Society in 1909 on "The Electron as an Element." He distinguished between the "congeries of rotating electrons," which (together with the positive nucleus) make up the atom, and the electrons which bind the atoms in compounds and determine the atomic valency; elements, he suggested, would contain up to five (rarely 6, 7, 8) of these valency electrons. Ramsay had recently constructed an atom model consisting of a ping-pong ball provided with two steel needles (polar axis extensions) dipping into mercury cups, and one or more split rings of insulated copper wire, glued to the ball, each ring representing an electron or its circular orbit (in a degree of latitude). The ends of the wires were connected to the two needles, and a current could be passed through the ring, from the upper needle through the wire to the lower needle, or *vice versa*, clockwise or anti-clockwise. When current was flowing, two balls near one another would so rotate that their rings attracted or repelled one another, and the balls would come to rest in different positions. Thus chemical combination and valency were exemplified.

Sir William Ramsay presented a very large number of papers to many British and foreign learned societies. He translated Beilstein's Analysis, wrote a System of Inorganic Chemistry, 1891; Elements of Systematic Chemistry; the Gases of the Atmosphere, 1898; Modern Chemistry, 1901; Essays, Biographical and Chemical, 1908; and edited the series of Text-Books of Physical Chemistry recently published by Messrs. Longman. His work met with the widest and fullest recognition, national and international. His knighthood (K.C.B.) dates from 1902; he was a Commander of the Italian Crown, Officer de la Légion d'Honneur, and a Knight of the Prussian order Pour le Mérite (civil class). Almost all the scientific academies of Europe (including Amsterdam, Geneva, Berlin, Prague, Vienna, and also Mexico, &c.), had elected him an honorary member. The Royal Society awarded him the Davy Medal, the Chemical Society the Longstaff Medal in 1903; he was accorded the Smithsonian Prize, and in 1904 the Nobel Prize. We have mentioned his presidency of the Chemical Society; he was also President of the International Congress of Applied Chemistry, held in London, 1909, and of the British Association at Portsmouth in 1911. Sir William married, in 1881, Miss Margaret Buchanan; we have spoken of their son; their daughter is the wife of Major H. L. Tidy, Professor of Pathology in London.

GERMAN SUBMARINE-BOAT DEVELOPMENTS.

THE exhibition of a German mine-laying submarine boat in the Thames is not only gratifying to the general public, but of great interest to all interested in the design of such craft, particularly in view of other developments, of which details come to us through Amsterdam. The weekly technical journal *Prometheus* indicates that there is building a submarine cruiser of 5,000 tons and of 400 ft. in length, "as strongly protected and armed as medium-sized protected cruisers." The propelling machinery is said to develop 18,000 h.p., to give a speed on the surface of 26 knots, and when submerged of 16 knots. The radius of action is from 18,000 to 20,000 nautical miles, which would enable the vessel to travel from the Baltic to Japan without replenishing the fuel bunkers. No particulars are available as to guns, but it is said that the vessel will have 30 torpedo tubes, and that in addition to torpedo in each tube there will be carried two reserves for each tube, making 90 in all. Provision is also being made for carrying over 100 mines, and for dropping them through the bottom of the ship. All this may be accurate, although the number of the torpedo tubes seems large, even for a vessel of 400 ft. in length, especially in view of the great space which will require to be given up to the propelling machinery. That developments in submarine design are probable there can be little doubt.

In any case the mine-laying submarine which we have captured, and which is now on exhibition on the Thames, is of great interest. There are in the forward part of the vessel six vertical tubes, extending from the top to the bottom of the ship, the upper end of each being covered by a grating which may be boarded over, while the lower end is open to the sea, so that the mines can be dropped through. These tubes are set at a slight inclination, the more effectually to ensure that the travel of the mine down the tube and when emerging from the bottom opening will be in a direction opposite to that of the travel of the submarine boat. From the external view of the submarine, which we publish on page 90, it will be seen that, for the purposes of exhibition, one of the mines has been mounted forward and another abaft the conning tower. The mine is held in a vertical position in guides built up of angle irons with wheel bearings to enable the mine to pass free of those uprights which are secured to the anchoring weights. In these uprights recesses are formed so that plungers on the interior wall of the tube in the ship hold the mine in its correct position in the tube. Thus it is possible to carry two mines in each of the tubes, one above the other. The withdrawal of the plunger, which is effected from the conning tower, frees the lower mine, allowing it to drop through the bottom of the ship. The upper mine can be released later. A relay arrangement forms an important part of the mechanism of the mine itself, ensuring that the mine shall have no buoyancy for a considerable period after it has left the tube. This ensures that it will immediately sink, and will not in any way come in contact with the bottom of the submarine boat. Chemical control is adopted for determining when the wire rope shall begin to pay out to enable the mine proper to rise while the anchoring weight continues at the bottom. A hydrostatic valve is fitted for determining the depth that the mine will float below the water level.

Otherwise this submarine boat does not differ materially from the ordinary fighting craft, except that she carries no guns or torpedo tubes and is propelled at a low speed by a single screw. Forward of the mine-launching tubes is the chain-locker, &c., with an ordinary and a mushroom anchor, while between the tubes accommodation is arranged for the bottles for storing the compressed air. Abaft the tubes is a strongly built bulkhead. The next compartment is taken up with accumulators, and there is living accommodation above them. Under the conning tower there is the usual working chamber, and below it the ballast tanks with the usual Kingston valves. Abaft this, again, are accumulators, again with living quarters above. Then comes the engine room, with single-screw Diesel-Benz engine, having four cylinders, and abaft this electric generator motors, while extreme aft is the after trimming tank. The vessel is fitted with double skin and the usual reserve buoyancy tanks on each side, while over the top is fitted a light deck with sheet steel side coverings, enabling the ropes and tackle to be carried. Under this also are the lifting shackles, the sounding machine, the motor silencers, &c. The oil fuel is carried between bottoms. No figures are available as to the dimensions of the vessel, but she appears to be of about 200 tons displacement, and fully loaded her surface draught will be about 9 ft. The length is about 110 ft. and the beam about 11 ft. She has obviously been built in three sections for transport by rail or canal.

We give also, on page 90, a photograph, supplied by the Topical Press, of the German cargo submersible Deutschland, which made the trip to America with a small cargo of chemical and other commodities. Regarding this vessel we wrote at considerable length in a recent issue (page 40 *ante*) giving such particulars as were available. Her length is about 300 ft. and the beam 30 ft. The horse-power of the twin engines collectively is 2,600 brake horse-power, giving a speed on the surface of 14 knots. As we then showed, there was nothing extraordinary about the voyage of the ship, except the evidence it afforded of the ineptitude of the German merchant service under the silent pressure of our Navy. The weights required for hull, machinery and other necessaries left available only 350 tons as cargo deadweight carrying capacity.

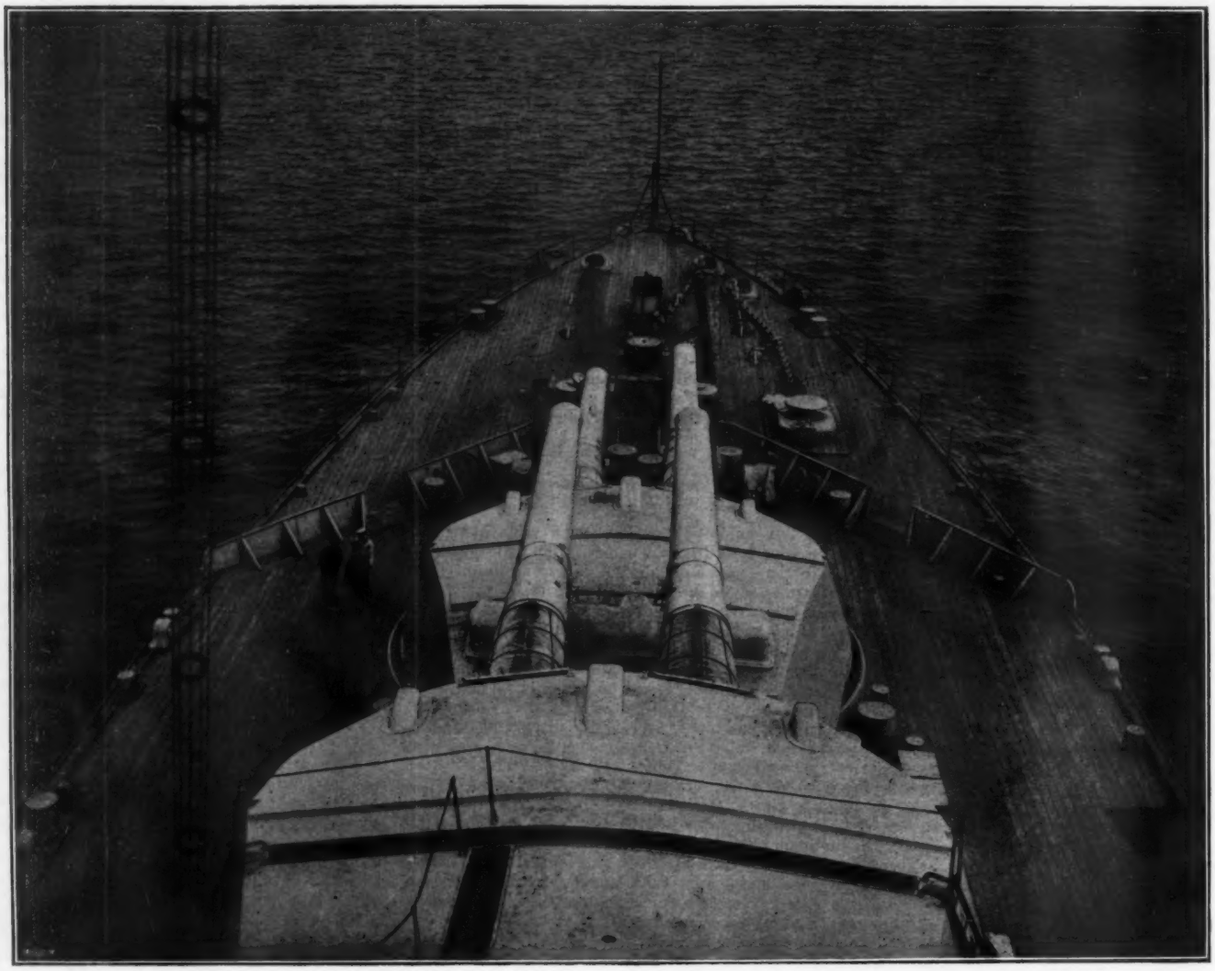
NOTES.

SHIPPING LOSSES BY WAR AND MISADVENTURE.

THE most authentic record of merchant shipping losses is that prepared by Lloyd's Register, and this week they have issued their quarterly return, which deals with the three months ended December 31 last. The total losses from all causes during these months were 331 vessels, of 600,936 tons, and of this tonnage more than two-thirds, or 167 vessels, of 409,587 tons, were due to the war. All losses, of course, are calculated in this total, whether by the Allies, the enemy, or neutral nations. It is a striking fact that the British war losses, notwithstanding that our merchant fleet to-day is more fully occupied than ever before in its history, make up in tonnage only 1.12 per cent. of the total tonnage owned in the United Kingdom. This is at the rate of about 4½ per cent. per annum, and forms in itself a clear indication of the comparatively small success of the German submarine attack. Although most of the German merchant fleet is safely locked up, either voluntarily in the ports of the Fatherland or compulsorily interned elsewhere, their total losses during the three months were 16 vessels, of 34,036 tons, all of these being vessels of less than 3,000 tons. The losses by war were 13 vessels, of 31,449 tons. This makes a proportion of 2½ per cent. per annum of the tonnage owned. The French losses from war

ONE OF THE LATEST BRITISH BATTLESHIPS.

(*For Notice see Page* 83.)



equal 1.6 per cent. for the quarter; those of Italy 1.8 per cent.; those of Japan just over 1 per cent.; and those of Norway 0.69 per cent. The outstanding feature is that the total losses of the British merchant fleet during the three months in question are only 1.5 per cent. of the total tonnage owned, or at the rate of 6 per cent. per annum, so that the shortage of tonnage is due more to the requirements of the naval and military services than to any destructive work of the enemy. The German losses are at the rate of 5 per cent. per annum, according to tonnage, which is in a way surprising, in view of the fact that German ships can only operate in the Baltic. The French losses for the past quarter from all causes are 2.1 per cent.; the Italian, 1.96 per cent.; the Norwegian, 1.9 per cent.; Swedish, 2.3 per cent.; and the Japanese, 1.27 per cent. Apart from war losses, wrecks account for the greatest number, namely, one-half of the losses due to misadventure. Thus 78 vessels, of 104,451 tons, were wrecked. Ships missing account for 28 vessels, of 31,578 tons, foundering for 23 vessels, of 21,247 tons, collisions for 13 vessels, of 14,603 tons, abandonment at sea for 14, of 10,518 tons, and fires for 6 vessels, of 8,612 tons. It is noteworthy that no ships whatever were voluntarily broken up or condemned during the quarter, they obviously being much too valuable in the present extraordinary condition of the shipping trade.

INTERNAL FRICTION OF METALS.

While the internal friction of liquids has been much investigated, the internal friction of solid bodies has not received sufficient attention, and there is indeed no general agreement as to the meaning of the term. In describing his recent investigation of the change of the internal friction of metals with temperature (*Zeitschrift physikalische Chemie*, vol. xcl., pages 232 to 247, 1916) Professor P. Ludwik, of Vienna, defines the internal friction R as that specific tangential stress which is required to cause a permanent relative displacement of the particles. In liquids the R would, in the first instance, depend upon the specific rate of displacement v and the temperature t; for $v = 0$, R would be 0 for liquids; but for solids R might be greater than 0, because any previous strain γ would have to be considered, and the R would generally increase with increasing γ, though it might decrease. In order to eliminate the influence of γ, the metal was submitted to a thermal treatment. The R, Ludwik has pointed out in his various memoirs on the testing of materials, can be deduced from the test diagrams. In the present research he simply determines the hardness by the cone-pressure method, and he plots the hardness numbers found—the pressure in kilogrammes divided by the area of the resulting impression circle in square millimetres—as ordinates against the temperatures as abscissæ. The pressure, ranging from 5 up to 1,000 kg., was applied by means of an Amsler machine, either rapidly within 30 seconds, or slowly within 300 seconds. The cone-angle was 90 deg. The metals experimented upon were of the highest commercial purity; there was some doubt as to the purity of the bismuth and antimony, however; the copper was electrolytic. The specimens were fused under layers of salts, cast and annealed; the specimen plate was laid on a plate of steel within the electrically-heated bath, which consisted of a cylinder oil for temperatures up to 300 deg. Cent., and of nitrates for temperatures up to 600 deg. Cent.; the range investigated was 20 to 600 deg. Cent. A farily steady decrease of the hardness with rising temperature was observed in all the cases. The curves were nearly straight or only slightly hollow (when the hardness diminished, first rapidly and then slowly) in the case of tin and bismuth; cadmium, lead, zinc, antimony yielded more hollow curves; aluminium and copper yielded graphs curved in the opposite sense and somewhat S-shaped, *i.e.*, the decrease in hardness with rising temperature was first slow, and became more rapid afterwards, to diminish again. There was some questionable indication of the influence of the different modifications of a metal in the case of tin, *e.g.*, but those influences appeared weak, whilst tensile tests of iron and nickel show a decided influence of the allotropic modifications. All the metals heated up to their melting points possessed still considerable hardness immediately before melting, when the internal friction of the solid would thus appear suddenly to pass into the viscosity of the molten metal. Thus, near its melting point, tin (and also bismuth) still marked 10 per cent. of its internal friction at 20 deg. Cent.; lead went down to 7 per cent., cadmium to 2 per cent., zinc to 1½ per cent. of the original R. When the curves for the different metals are plotted in one diagram, some of the hardness curves are seen to cross; this holds

for equal temperatures as well as for homologous temperatures; in the latter case the melting-point temperature is taken as unit. This shows that the change of hardness with temperature is not uniform for different metals. The rate of applying the pressure has also to be considered; the above-given figures for the reduction of the hardness refer to slow loading.

THE SIR WILLIAM WHITE MEMORIAL.

The movement for some commemoration of the late Sir William H. White, K.C.B., perhaps one of the best-known naval architects in the world, was consummated on Wednesday last, when there was formally handed over to the custody of the Institution of Civil Engineers a panel, with a bas-relief portrait of Sir William White, erected on the walls of the ground floor of the Institution of Civil Engineers immediately to the right of the entrance. But, as mentioned by Admiral Sir Reginald Custance, the Chairman of the Executive Committee, the preponderating part of the fund collected was utilised to found a research scholarship, which would have perhaps appealed most to the heart of the late Sir William. The company at the ceremony on Wednesday included Earl Brassey, G.C.B.; Sir Thomas Devitt, Bart.; Sir John Wolfe-Barry, K.C.B.; Admiral Sir Reginald Custance, K.C.B.; Admiral Sir Cyprian Bridge, K.C.B.; Sir Douglas Fox; Sir William Matthews, K.C.M.G.; Sir W. E. Smith; Mr. Alex. Ross; Dr. W. H. Maw; Mr. Tennyson D'Eyncourt, C.B.; Mr. Dugald Clerk; Mr. Campbell Swinton; Colonel Saxton White; Dr. Tudsbery; and Mr. R. W. Dana. Lady White and her daughter were also present. Sir Reginald Custance, in opening the proceedings, referred to Sir William White's great services to the country and to the science of naval architecture, and particularly to the influence of his life. He mentioned that spontaneous contributions had come from America and other countries over the seas and that the total sum realised was over 3,000*l*. Earl Brassey, who followed, referred at some length to Sir William's work, and particularly in the formation of the Royal Corps of Naval Architects, which had had very great effect in improving the status of the naval architect. Lord Brassey also spoke of his great admiration for the personal qualities and professional ability of Sir William. Sir John Wolfe-Barry, as a member of the Executive Committee and a life-long friend of Sir William White, referred to the immense value of his work and influence, not only in naval architecture but in civil engineering, especially in connection with the development of scientific research and technology. Mr. Alexander Ross, the President of the Institution of Civil Engineers, in accepting the custody of the memorial, referred to Sir William's work on behalf of the Institution of Civil Engineers, and particularly to his qualities of leadership on the occasion of the visit of the Institution to America, and to the imperial note which he always struck in his public utterances. It may be added that the panel is in marble and alabaster, showing in profile a head of Sir William White, while in the distance there is outlined a ship of the King Edward VII. class, the last type of battleship which he designed. The sculptor is Mr. A. G. Walker, who was also responsible for the Florence Nightingale statue; he is to be congratulated on his work. Underneath the panel is the following inscription:—"Sir William Henry White, K.C.B., LL.D., D.Sc., F.R.S., President 1903-1904, Director of Naval Construction, 1885-1902. A tribute from the shipbuilders and engineers of many nations."

HYDRATED LIME IN CONCRETE.—In a recent paper read before the Engineers' Club of St. Louis, says the *Engineering and Mining Journal*, New York, Mr. H. E. Wiedemann gave the following as his conclusions regarding the use of hydrated lime in concrete. The use of small amounts (8 per cent. added to a 1 : 2 : 4 mixture, up to 16 per cent. added to a 1 : 3 : 5 mixture) will:—(1) Render the concrete highly plastic and homogeneous, producing density and uniformity in the finished product. (2) Add to the life and efficiency of a concrete pavement or floor, on account of the uniform resistance to wear and internal stress produced by its use; and (3) render concrete water-proof by filling the voids in the fine and coarse aggregate. These functions are of the greatest importance, and warrant the use of hydrated lime.

LITERATURE.

The Telephone and Telephone Exchanges, their Invention and Development. By I. E. KINGSBURY, M.I.E.E. Illustrated. London: Longmans, Green and Co. [Price 12s. 6d. net.]

THE history of invention is always interesting. To live again among the pioneers of applied science, to watch the means by which they explored untried ground, to mark their failures and their successes, is instructive, while the study of the steps by which complicated processes have been reduced to extreme simplicity is both stimulating and educative. The telephone has now been at our command for a generation, its use has become a matter of course; we no longer give thought to the convenience received, or to the skill and care displayed in providing the service, still less do we acknowledge the debt of gratitude we owe to those who laboured strenuously to accomplish the very notable result by which intercourse has been quickened and trade and commerce facilitated. Nor do we attempt to discriminate among those by whose joint efforts final and complete success has been won. Mr. Kingsbury by his book tries to do justice to those who assisted at its inception forty years ago, who fought against opposition and apathy, and by indefatigable exertion organized and systematized the development of the telephone. He places us behind the scenes, he shows us the mental work and enables us to dovetail the several pieces of an intricate organism into an effective and smooth working machine. In his general treatment he has been well advised to limit the work to moderate dimensions. It is easy to overlay the history of a far-reaching invention with so much detail that the sense of proportion is lost and the interest allowed to flag. Moreover, however strongly the description of patents may appeal to the expert, the general public, to whom we understand this work to be addressed, can soon weary of that kind of literature. In the abbreviated form for which the author apologises, is it quite possible to follow the direction that invention has taken, to trace the causes that have operated, and to emphasize the salient points in the development of an industry of incalculable advantage to the human race.

The author disclaims the intention of writing the history of the telephone industry in its entirety, though he originally contemplated such a task. In this work he has limited his survey to the principal inventions that progress has necessitated, "to the developments resulting from them, and the influences bearing upon them with all the detail that space permits." This is his own description of an elaborate piece of work, and the modified course may explain the tendency to linger over episodes in the past, whose interest has faded through lapse of time, and to give but brief mention of recent advances. The work might have been improved by more equality of treatment. The impression is created that invention was practically stayed at the end of the last century, and that ingenuity was exhausted. We would have liked to have heard more of the possibilities of wireless telephony, but no mention is made of that striking expansion of the original process. Automatic exchanges and the elimination, whole or partial, of the operator excite considerable attention at the present moment, but though the author has a chapter on this subject, the information is confined mainly to the suggestions of the early promoters and he has little to say of the results of the more recent experiments. It is most desirable to have the progress in the past carefully discussed and the claims of rivals carefully balanced, but not less important to see clearly defined the road along which modern research and methods are proceeding.

Naturally Mr. Kingsbury is anxious to do justice to those who bore the burden of the day, and to resuscitate reputations that have suffered from accident or unfair treatment. Among those who for a while were unjustly slighted is Alexander Graham Bell, to whom the world is indebted for the discovery of the essential principle of the master invention, and the requisite means to make that principle effective. To insist on the due recognition of his claims cannot but have the appearance of overstating them, and of arousing a little irritation at the emphasis with which they are vindicated. Mr. Bell, like Morse, in another department of telegraphy, has suffered from detractors and misrepresentation, and has had to appeal to the law courts to uphold his claims to priority and originality, and though such a course must have been painful and costly, it has not been without its compensations. Those courts have amply supported his rights, and by the thorough and careful sifting of evidence, as well as by their solemnly recorded judgments, made his position secure for all time against the lapses of ignorance or the wiles of imposture. There seem few grounds therefore for inveighing against the action of the Royal Society, and for making the award of the Hughes Medal to Bell the occasion for some rather uncomplimentary remarks on the conduct of that body. The terms of the award as stated by the President are not those quoted by the author. Sir Archibald Geikie justifies the bestowal of the medal to Mr. Bell because "his preponderating share in the invention of the telephone, now so long ago as 1876, and his practical investigations in phonetics have laid modern civilization under deep obligations to him, while his numerous other inventions and experiments show the versatility of his genius." There is nothing ungenerous in these remarks, and if any objection can be taken, it should be simply on the ground of undue delay.

The early work of Graham Bell is treated both fully and sympathetically. We are enabled to follow the process of invention and see how it differed in thoroughness and design from the attempts of predecessors. Bell treated the problem underlying telephonic transmission as one of acoustics, and in his early efforts to understand the formation of vowel sounds and the theory of articulation he independently reproduced some of the experimental results that Helmholtz has made classical. He had not at that time sufficient knowledge of electricity to understand the methods employed by Helmholtz. He was not discouraged however, but determined to acquire sufficient acquaintance with electrical science to be able to follow the German master. This deficiency pursued him for a long time; ten years later, when he had made some progress in his design and the prospect of telegraphing vocal sounds seemed feasible, he confessed to Henry that he was wanting in that technical knowledge which would enable him to achieve success. "Get it," was Henry's laconic answer; stern advice that revealed the Professor's knowledge of the character of the man with whom he was dealing. Bell did not need sickly flattery or condolence, but a bracing discipline, and he fortunately followed Henry's salutary counsel. Strength and confidence grew with increasing knowledge, and though in one particular and important direction he was assisted by fortuitous accident, Bell appears in his experiments to have proceeded with system and to have devised his instrumental equipment with full knowledge of its manner of operation. Otherwise he would not have been so ready to seize the significance of his one lucky accident, that led to the conception of the undulatory current. Accident taught him or gave him the insight that magneto-electric currents, generated by the vibration of an armature in front of an electro-magnet, were capable of producing audible effects that could be utilized for the purpose of transmitting speech. The time of the discovery was as fortunate as the revelation was complete. It was one of those coincidences that occasionally combine to favour the projects of ardent enthusiasts, and supply the necessary stimulants in face of continual discouragement. Capitalists who were supporting Bell did not appreciate what the invention of a talking instrument meant; they looked for the discovery of a process that would promote multiple telegraphy, and were growing impatient of delay. The transmission of articulate sound was an idle chimera to financial magnates, who could not grasp its commercial possibilities till the invention was complete and on the market. But the accidental discovery was of value in commercial telegraphy, it promised the fruition of intelligible schemes, and in this way secured to Bell a longer lease in which to carry on his researches.

The skilled scientist could at once express his hope for future possibilities and tender his congratulations. To Sir William Thomson, who knew nothing of Bell and his schemes, the inchoate invention appealed with great force. He saw the instrument and the method of working for the first time at the Centennial Exhibition of Philadelphia in 1876, and at once hailed it as the most wonderful thing he had seen in America. The undulating current he declared to be a great and happy conception, that "before long would enable friends to whisper their secrets over the electric wire." The value of exhibitions and the encouragement afforded by the testimony of competent judges were decisively displayed in this instance. After describing the means by which variations in the strength of the current were produced in proportion to the velocity of a particle of air moved by the sound, Sir W. Thomson (Lord Kelvin) declared without hesitation that Mr. Bell would supply an instrument for "making voice and spoken words audible through the electric wire to an ear hundreds of miles distant." One can admire the intuitions of trained scientific judgment, that could leap over so many difficulties that stood in the way of a completely successful issue, hardly less than the persevering efforts of the inventor, who after indefatigable exertions had enabled the halting accents of imperfect articulation to be recognized at the distance of a few feet.

Bell, as Professor Clerk Maxwell said, was not an electrician who had found out how to make a tin plate speak, but a speaker who to gain this end had become an electrician. The simple means he employed distinguished him from his competitors, and from those who, like Wheatstone and Reis, had been attracted by the same problem. This author sketches in some detail the tentative proposals of these, more especially the latter, who may be considered the forerunner of Edison in telephonic experiments. Having accomplished the task of making distant conversation possible, having given to telegraphic messages the advantages of inflection and emphasis and all that audibility implies, Bell practically drops out of the tale and takes no prominent part in effecting those mechanical arrangements which were necessary to commercial success. New names that have long been honoured appear on Mr. Kingsbury's pages, names of men who have solved problems connected with the selection of suitable wires, the construction and simplification of switchboards, and the establishment of exchanges, that final triumph of organization, that has brought the telephone within the range of daily life. The author has done wisely in combining the history of progress in exchange management with that of the telephone, for it is necessary to keep both in sight if we are to grasp what ingenuity has accomplished in furthering this plan of inter-communication. Familiarity has blinded our appreciation of a system so perfectly adjusted that with the least possible delay a subscriber can be put into communication with another subscriber selected from many thousands. When momentary failure occurs and conversation is interrupted, we all experience a sense of irritation, but if we better understood the elaborate machinery whose details are completely hidden, we should exhibit a little more patience. The author's clear account of these important developments should hold the attention. He records a fascinating chapter in the history of invention, one of successful achievement and deserving of more study than has been given to it.

Perhaps it was fortunate that on the introduction of the telephone the public, both in Europe and America, did not display any great eagerness to avail themselves of its service, for there was no experience of the work of the exchange and no statistics to determine the requirements and results. Had there been a rush of subscribers, congestion and breakdown with consequent unpopularity must have followed, for the possibilities of the multiple switchboard, as of other time-saving devices, had not been demonstrated, and electricians had to learn, to adapt, and to construct what was necessary for continuous and ready service. Induction, that trouble whose effects the penetrating intuition of Sir F. Ronalds had foreseen half a century earlier, had to be overcome, call-bells had to be devised, the "branching" system had to be worked out, the most appropriate insulation of cables had to be settled, and all at a time when economy and rapidity of construction were prime desiderata. While the value of the new means of intercourse had to be demonstrated and the issue was still in doubt, capital was not readily forthcoming. Those who had the greatest faith and confidence had to venture the most, in order to tide over the initial stages, and the path of the early pioneers was not one of roses. It is no wonder if in those critical times an element of haphazard could be detected in the design and an excusable effort to secure cheapness of construction manifested itself.

A welcome feature in Mr. Kingsbury's book is the frequent reference to reports of the National Telephone Exchange Association held from time to time in the States, to advance the interests of the companies who were licensees under the Bell patents. These conventions were happily conceived; they did much to remove the difficulties at which we have hinted. They diminished friction, promoted uniformity, and circulated information. It was early recognized that excellence could not be ensured merely by adopting individual opinion however experienced, that ventilation and intelligent criticism were necessary for the maintenance of a continuous policy, destined to secure the operation of that system that had shown distinct merit. The proceedings of these conferences at which experts could submit their proposals did much to place the arts of telephone exchange and management on a scientific basis. Keen students of individual problems in various countries were adopting a scientific attitude towards the telephone system as a whole, but apparently it was only in the United States that organized efforts, aiming at advances and improvements in the exchange methods, obtained systematic support. It may be a consequence of the struggle after excellence and a satisfactory service that telephony has found its quickest and greatest developments in America. To every thousand of population there are ninety-seven telephones in use, a result that cannot be approached elsewhere. Canada is a fair second, but in Great Britain there are only seventeen per thousand inhabitants, and scientific Germany can only boast twenty-one. Other causes have contributed to give America the lead she enjoys, and among these must be considered the adoption of a policy which tended to prevent competition, for it must be thoroughly accepted that competition in telephone service is wasteful and a public disadvantage, since the result must be duplication rather than healthy competition. In this country there was long competition between the telegraphic system as worked under the Post Office monopoly and the telephone. Doubtless the intentionally restrictive policy inaugurated by the Post Office in 1881, which limited telephone exchange communication to a radius of 5 miles from a defined centre, discouraged enterprise while the terms permitting the use of trunk lines did not favour a rapid development. We have, however, no intention of discussing these vexed questions. They are referred to here only to show the wide scope that Mr. Kingsbury's review takes of this important subject, the extensive ground he covers, and the numerous interesting topics that come under consideration, and are generally treated with thoroughness and impartiality.

The Marine Steam-Turbine. By J. W. M. SOTHREN. Fourth Edition. London: Crosby Lockwood and Son. [Price 18s.]

THE first edition of Mr. Sothren's treatise, published in 1906, marked a new departure in works dealing with the steam-turbine. For obvious reasons, those who had borne the heat and burden of the day in "practicalising" the steam-turbine were legitimately anxious to keep to themselves so far as possible the fruits of their experience. Writers on steam-turbines at that date were accordingly perforce compelled to treat their subject almost entirely from the standpoint of hydraulics and thermodynamics. Moreover, lacking the check which would have been provided by a comparison of their theoretical results with the data given by experience, conclusions were in some cases arrived at which further knowledge has shown to be erroneous. The publication of Mr. Sothren's book marked accordingly a new era. In this, for the first time, appeared accurate details of many of the essential parts of marine steam-turbines, together with some notes on the behaviour of these prime movers, based upon actual experience at sea. In the numerous additions and emendations made to his original volume Mr. Sothren has followed consistently the same plan of dealing in the main with the work of constructing and running the turbines.

The new issue now under review does, however, contain a detailed and simple description of the various uses of the temperature entropy diagram, which will no doubt be serviceable. The principal value of the volume, which now comprises 545 pages of text and 116 illustrations, rests, however, on the numerous minute descriptions of turbine details together with additional notes on the results of sea experience.

Many of the new illustrations are devoted to reproductions of the working drawings of turbines of different types. Of these a large proportion have been reproduced (by consent) from our columns. In addition to these the diagrammatic general arrangements, which show clearly the situation and object of the various parts, are certain to be found particularly useful. Students often find that the elaboration of detail, necessary in an actual working drawing, makes it difficult for the tyro to see readily the nature and function of many of the component parts.

The book, which is well printed, is provided with an extensive index and will undoubtedly prove as popular and helpful as its predecessors.

Catalysis and its Industrial Applications. By E. JOBLING, A.R.C.Sc., B.Sc., F.C.S. London: J. and A. Churchill. [Price 2s. 6d. net.]

THE small volume of 120 pages before us belongs to the series of text-books of Chemical Research and Engineering, which opened, we think, with the very useful "Introduction to the Physics and Chemistry of Colloids," by E. Hatschek. These books are somewhat of the nature of primers, and one must not look for much technical detail in them. To the greater public the subject of catalysis is perhaps less unfamiliar than that of colloids, but the volume is none the less very acceptable. Catalytic processes, *i.e.* processes which are accelerated or retarded by catalysts, materials which affect the velocity of a chemical reaction without appearing in the final products—to use Ostwald's definition, which the author adopts—have become rather the rule than the exception. Without touching upon the mathematics of the theory, the author explains the nature of positive and negative catalysis, the incapacity of catalysts to start a reduction and their own sensitiveness to the action of promoters and poisons, substances which, like the catalysts themselves, have powerful effects even when present in very small quantities. He classifies catalytic agents as: (1) chemical agents which function by means of intermediate reactions—this class comprising the so-called carriers and substances which cause cyclic action; (2) physical agents, finely divided materials, hot and cold surfaces, &c., depending in their action upon surface tension, occlusion, diffusion, &c.; (3) indeterminates apparently combining more or less the above functions. The author then proceeds to a review of catalytic processes, the chief chapters being devoted to sulphuric acid manufacture (by the chamber and the contact processes, both catalytic); the chlorine, salt cake and sulphur recovery processes (Deacon, Hunter, Hasenclever, Hargreaves-Robinson, Claus-Chance); the fixation of atmospheric nitrogen (Haber, Ostwald, Serpek); surface action and combustion (Lucke, Bone-McCourt); hydrogenations, dehydrogenations and oxidation, and dehydration and hydrolysis. Some of these latter chapters dealing with alcohols, ethers, organic acids, hardening of oils, indigo and other colours, saponification, &c., are almost too sketchy, though rich in suggestions. The wealth of organic reactions referred to is connected with names which are mentioned, but the reactions are often insufficiently explained, and as these names are not entered in the index—which is far

too short—and as the volume is practically devoid of literature references, moreover, the reader may tire. Clear on the whole in his language, the author speaks of reduction, where "addition of hydrogen" would be more to the point, and of cyclic compounds reverting to the "original" body, a phrase which is likely to be misunderstood. On the last page Mr. Jobling alludes to the hastening of the solution of zinc, &c., by the presence of impurities, without saying a word about electric action. The book was probably finished under stress of time, when the author joined the Forces, and it has remained practically "Reprinted from the *Chemical World*," against the original intention. Yet it is quite a useful introduction into technical catalysis.

BOOKS RECEIVED.

Slide Valves and Valve Gearing. By PETER YOUNGSON. Glasgow: James Munro and Co., Limited. [Price 7s. 6d. net.]

A London Transport Trust: Criticism of an Impracticable Scheme. By EDWIN A. PRATT. London: P. S. King and Son. [Price 1s. net.]

Discovery: or the Spirit and Service of Science. By R. A. GREGORY. London: Macmillan and Co., Limited. [Price 5s. net.]

A Text-Book of Practical Hydraulics. By JAMES PARK. London: Charles Griffin and Co., Limited. [Price 12s. 6d. net.]

The Physico-Chemical Properties of Steel. By C. A. EDWARDS, D.Sc. London: Charles Griffin and Co., Limited. [Price 10s. 6d. net.]

Centrifugal Pumps and Suction Dredgers. By E. W. SARGEANT. London: Charles Griffin and Co., Limited. [Price 10s. 6d. net.]

The Story of the Canadian Pacific Railway. By KEITH MORRIS. London: William Stevens, Limited. [Price 3s. 6d. net.]

Machinery's Screw Thread Book. Compiled and edited by C. EDGAR ALLEN, A.M.I.Mech.E. London: The Machinery Publishing Company, Limited. [Price 2s. 6d. net.]

The Munitions of War Acts, 1915 and 1916. By JOHN CHABTRES, London: Stevens and Sons, Limited. [Price 5s. net.]

Industrial Gases, including the Liquefaction of Gases. By GEOFFREY MARTIN, D.Sc.; ERNEST A. DANCASTER, B.Sc.; J. M. DICKSON, B.Sc.; FRANK B. GATEHOUSE, F.C.S.; E. JOPLING, A.R.C.Sc.; and H. STANLEY REDGROVE, B.Sc. London: Crosby Lockwood and Son. [Price 7s. 6d. net.]

The Motor-Boat Manual. Compiled and illustrated by the Staff of *The Motor Ship and Motor Boat.* Seventh Edition. London: Temple Press, Limited. [Price 1s. 6d. net.]

Large Electric Power Plants, their Design and Construction, with examples of Existing Stations. By Dr. G. KLINGENBERG. English Translation. London: Crosby Lockwood and Son. [Price 25s. net.]

The Heat Treatment of Tool Steel. By HARRY BREARLEY. Second Edition. London: Longmans, Green and Co. [Price 10s. 6d. net.]

Ruler and Compasses. By HILDA P. HUDSON. London: Longmans, Green and Co. [Price 6s. net.]

All the World's Aircraft (originally known as *All the World's Airships*). Founded and edited by the late FRED T. JANE. C. G. GREY, Technical Editor. Seventh yearly issue. London: Sampson Low, Marston and Co., Limited. [Price 21s. net.]

REPORT OF THE COMMITTEE ON THE ROYAL AIRCRAFT FACTORY.

A PARLIAMENTARY PAPER (Cd. 8191), issued on Wednesday, gives the report of the Committee on the Royal Aircraft Factory, the members of which were Sir Richard Burbidge (chairman), the Hon. Sir Charles A. Parsons, K.C.B., and Sir Frederick Donaldson. The last-named, we may say, signed the report before his regrettable death owing to the sinking of H.M.S. Hampshire. The Committee was instructed "to inquire and report whether, within the resources placed by the War Office at the disposal of the Royal Aircraft Factory and the limits imposed by War Office orders, the organisation and management of the factory are efficient, and to give the Army Council the benefit of their suggestions on any points of the interior administration of the factory which seem to them capable of improvement."

As the report reached us too late to permit of considered analysis in this week's issue, we defer comment, contenting ourselves by reproducing the conclusions arrived at and the recommendations made.

CONCLUSIONS.

Such an experimental establishment as the Royal Aircraft Factory should be in existence. On its present wages cost the factory efficiency could be enhanced as an experimental place and a substantially increased volume of finished work produced, provided a sharp line of demarcation be drawn between experimentation and commercial productivity, and the factory be reorganised and managed as nearly as possible upon a commercial and engineering basis.

The existing undesirable trade feeling should be met and, if possible, overcome, and the competition of the Royal Aircraft Factory with the trade should not, if reasonably administered, be the cause of any detrimental friction or trade feeling.

If the complaint that British airmen suffer from want of speed in aeroplanes is well founded, there would appear to have been some lack of foresight (whether on the part of the Royal Aircraft Factory or the War Office is not clear) as to the size of engines required to meet war conditions. The Committee are informed that higher-powered engines are now being bought from the trade, that some have already been delivered, and are being fitted into concurrently-produced machines.

During the period of war activity the financial resources placed at the disposal of the factory for experimental purposes have been ample to allow experimental work to be expeditiously performed in an efficient manner, and in a degree which should have placed useful and essential data at the disposal of the War Office, Admiralty, and private trade. The Committee have no information as to the extent which the Admiralty have availed themselves of the data put at their disposal.

The emoluments offered to heads of departments and others of high technical ability have been too low and are hardly likely to attract many highly qualified gentlemen, or, if attracted, to retain their services. The work done by the staff merits more consideration than has hitherto been accorded. The weakness inherent to a system of under-payment has been most materially counteracted since the outbreak of the war, because many gentlemen of the highest ability and standing, whose positions in private work command salaries of possibly many hundreds or even thousands per annum, are working at salaries so small as to be negligible in their cases.

The numbers now engaged in the central office, stores, and other departments of a non-productive nature reveal an organisation more liberal than is generally found in Government establishments, and on a scale unknown to the Committee in private works.

Experiments and other manufacture have not infrequently been delayed owing to lack of material. A carefully selected larger stock of materials constantly used should more than earn the interest on the capital involved.

An experimental establishment of this magnitude should be provided with a full equipment of labour-saving devices, which are undoubtedly necessary for economic and most rapid production. From such resources, properly utilised, a reduction in number of employees now necessarily working round a particular operation could be effected.

The Committee understood from General Sir David Henderson that he has contemplated strengthening the Department of Aircraft Equipment in London by transferring the designs portion of the Royal Aircraft Factory to London, but they are strongly of opinion that any attempt to separate the designs branch from the shops would be disastrous.

Summing up, the Committee say that while fully alive to the ungrudging work done under the trying conditions of war pressure by the Superintendent and staff of the Royal Aircraft Factory, they think there are parts of the organisation and management where improvements are possible.

RECOMMENDATIONS.

The Committee make the following suggestions:—

A Board of Management be formed consisting of a chairman or director of the Royal Aircraft Factory, a superintendent of designs and a superintendent of manufacture, all preferably civilians, who should give their whole time to the affairs of the factory, and a military adviser without distinctive executive duties. The three last-named gentlemen should rank equally with one another on the board.

The director should be well equipped with previous commercial and scientific engineering qualifications and experience, but it is not essential that he should possess any intimate or previous knowledge of aviation. He should be selected for his recognised ability in administration and management.

The organisation suggested would be much assisted by the appointment of a civilian of high standing and suitable qualifications as controller of aircraft supplies, with headquarters in London, and among his duties the direct communications with contractors and the Royal Aircraft Factory.

As the Committee believe that the capacity of the factory could be greatly augmented without increasing the number of employees, they suggest that this should be arrived at in the shape of additional current manufacture of aeroplanes and engines, without impairment, and, indeed, with increased efficiency of the experimental functions of the Royal Aircraft Factory.

Special and strenuous efforts should be made immediately both by the Royal Aircraft Factory and by financial assistance, if necessary, to the trade, so that the most rapid production of all the high-powered engines may be secured.

It would be better that direct contact with contractors, including the issue to them of drawings, should be made through a third party, *e.g.*, the Controller of Aircraft Supplies, and not by the Royal Aircraft Factory. Inquiries should first of all be made to the officer issuing drawings, presumably the Controller of Aircraft Supplies, and he should put any particular contractor into touch with the Royal Aircraft Factory in order that any desired information, data or explanations may, when required, be afforded direct. This course would also keep track of alterations, if any, from the original approved designs. Of course, the Controller of Aircraft Supplies and the director of the factory would be in reasonably close touch.

No useful purpose would be served at this juncture by the submission of recommendations as to the central office and stores. If actually too elaborate, as they seem at present, the rearrangement of duties suggested would naturally lead to some change in this direction, but it should preferably be left for the action of the new board of management.

THE AIR BOARD'S COMMENTS.

Along with the report of the Aircraft Committee there is issued a rejoinder by the Air Board, of which Lord Curzon is Chairman. This is in the form of a report to the War Committee. After referring to the valuable public service rendered by Sir Richard Burbidge's Committee, and to several statements in their report, to which we will refer next week, Lord Curzon's Committee make the following comments upon the conclusions and recommendations reproduced above, stating that such comment is in conformity with Sir D. Henderson's views:—

They do not share the view of the Committee that the factory should be placed under a Board of Management. Such an arrangement, however suitable for a private factory, would in practice be found ill-adapted to the exigencies of military organisation. They hold strongly that the factory should be under the direction of a single Superintendent, possessing the special qualifications of business experience and administrative capacity required for the post.

Colonel O'Gorman has, in their opinion, rendered eminent public service in the design and construction of aircraft, and they think that these abilities can best be employed in the future in the capacity of Consulting Engineer to the Director-General of Military Aeronautics at the War Office.

Under the Superintendent, as now proposed, there should be a head of the Design branch and a head of the Production branch. Every effort should be made to obtain the persons best qualified for these posts.

The Air Board do not share the view of the Committee that a Military Adviser with distinctive executive duties should be attached to the factory. The functions indicated by the Committee can, in their opinion, be better discharged by the Director of Aircraft Equipment at the War Office.

The Board share the view of the Committee that communication between the Royal Aircraft Factory and contractors should be reduced to a minimum.

The Board do not, however, think it necessary to create a post of Controller of Aircraft Supplies for the purpose of acting as intermediary between the factory and the contractors. These functions can be adequately discharged by the Department of Military Aeronautics at the War Office, as at present constituted.

The proposal of the Committee that the capacity of the factory should be directed to an increase of the current manufacture of aeroplanes and engines raises a difficult question. There is no doubt that from a financial point of view such extension is desirable. The larger the proportion of production to experiment, the more creditable will the balance-sheet of the factory appear. On the other hand, not only does the present production of the factory, limited as it is, arouse some measure of suspicion in the minds of private manufacturers, but any such extension in the case of engines is, under existing conditions, impracticable. An increased production of engines could only be obtained if new shops were built. But there is no room for their construction, and even if there were, no output could be obtained in less than 10 months. The object to be aimed at, in the view of the Air Board, is an increase in the output of aeroplanes by an improved organisation of the existing staff. No reduction should be made in the amount of experiment conducted at the factory. On the contrary, this is the aspect of their work which it is desirable to emphasise by every possible means.

The Board have had under special consideration the question of increasing the output of engines by the trade. Much is being done in this direction, but the limiting factor is not financial assistance, which has not been stinted, but the lack of skilled mechanics. The Board have taken independent action in this respect.

The Committee have not dealt with the allegations, which have been made public, of defective internal administration of the factory, such as that the workmen employed were inadequately employed or extravagantly paid. The Board have examined this point, but think it best that the complaints on these heads should be referred to the new Superintendent of the factory, who should make it his duty, at an early date, to report upon them and to remedy any abuses which he may find to exist.

Any measures of reorganisation of the Royal Aircraft Factory should be adopted with the concurrence of the Air Board.

THE FUEL QUESTION IN DENMARK.—Immediately before the commencement of the war the wholesale price for ordinary household nuts in Denmark was 1 kr. 30 öre per hectolitre (about 17s. per ton); by degrees the price of 6 kr. (6s. 8d.) was reached in May, 1916, and has since been maintained. Coke cost in July, 1914, 1 kr. per hectolitre, while the present price is 3 kr. 50 öre. Peat has to some extent followed this upward movement, although the accelerated production told upon the quality—the quotations rising from 4 kr. to 10 kr. per 1,000 pieces, a maximum price of 25 kr. (27s. 6d.) per ton in Jutland and 27 kr. per ton in Seocland has now been fixed. The municipality of Copenhagen and the other Danish towns have formed a coal bureau in order to ascertain the requirements of the different municipalities, the tonnage likely to be available, &c.

GERMAN SUBMARINE-BOAT DEVELOPMENTS.

(*For Description, see Page* 85.)

FIG. 1. THE MINE-LAYING SUBMARINE "U C 5."

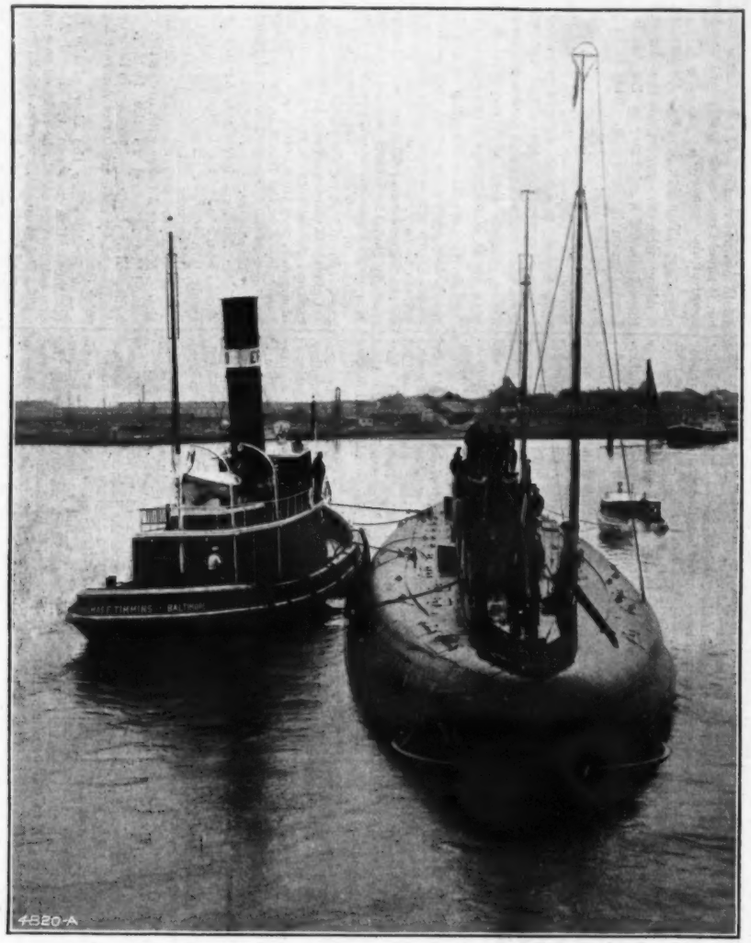


FIG. 2. THE CARGO-CARRYING SUBMERSIBLE-BOAT "DEUTSCHLAND."

INDIAN RAILWAY ADMINISTRATION.—The East Indian Railway, properly so called, now comprises seven-eighths of a mile with six tracks, 3½ miles with four tracks, 24½ miles with three tracks, 610¾ miles with double tracks, and 1,808¾ miles with single track. In addition to this mileage, the Delhi, Umballa and Kalka Railway, 191½ miles, and the South Behar Railway, 79¼ miles, were worked last year by the East Indian Company, making the aggregate length worked at the close of March, 1916, 2,719 miles. The mean length of line worked, including foreign lines worked over (54½ miles), during the past half-year was 2,772¾ miles. The ratio of the working expenses to the traffic receipts in 1915–16 was 38.5 per cent., as compared with 38.92 per cent. in 1914–15. The aggregate distance run by trains in 1915–16 was 25,658,408 miles, as compared with 25,439,058 miles in 1914–15. The quantity of coal carried in 1915–16 was 10,792,039 tons, as compared with 10,991,995 tons in 1914–15. The quantity of coal interchanged with foreign lines in 1915–16 was 3,162,341 tons, as compared with 2,732,715 tons. In down coal traffic there was a falling-off of 314,419 tons during the past half-year in the weight carried; this falling-off occurred entirely in coal for export, and it was due to scarcity of tonnage and high sea freight rates at Calcutta. Owing to this, coal for the western side of India was conveyed by the all-rail route, and this, as in the previous half-year, led to a large increase in the up traffic. There was a falling-off in steamboat earnings in the past half-year; this was due to the closing of ferry services at Moughyr and Munihari on the Ganges, in consequence of the commandeering by the Anglo-Indian Government of the company's steamers for war purposes. There was an increase in maintenance expenditure in the past half-year, in consequence principally of a large expenditure in relaying and improving the tracks in the Delhi districts and providing further facilities in the Howrah district for dealing with goods traffic. The output of coal at the company's collieries in the six months ended with March this year was 393,262 tons; the quantity of coal consumed by the undertaking, including coal purchased, was 463,347 tons. Work on a relief line from Burdwan to Howrah was delayed in the past half-year in consequence of the flooded state of the country, but good progress has since been made, and it is now anticipated that the line may be opened for traffic at the close of 1916.

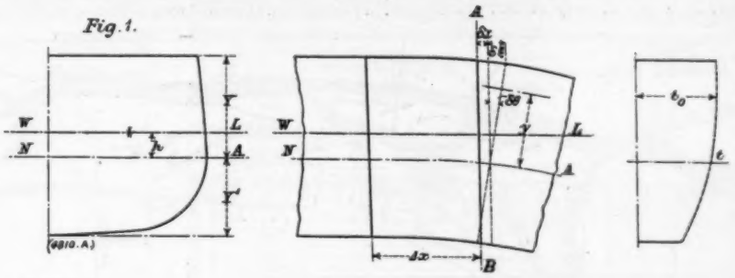
DEFLECTION OF SHIPS DUE TO TEMPERATURE INFLUENCE.*

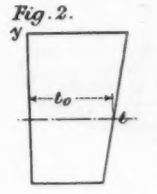
By Dr. K. SUYEHIRO, Member, and T. INOKUTY, Junior Member.

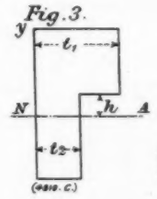
(THE importance of investigating the present subject was first noticed by Professor Purvis, who suggested to one of our students to study this as a topic for his graduation essay. However, most likely due to lack of time, the student was unable to solve the problem set to him. So we have endeavoured to investigate the subject sufficiently to get some hints in this direction. Under such circumstances, several points involved in the present paper—for instance, the relation of stresses in heated and unheated portions and the assumption (2) as to temperature distribution—are due to the suggestion by Professor Purvis.)

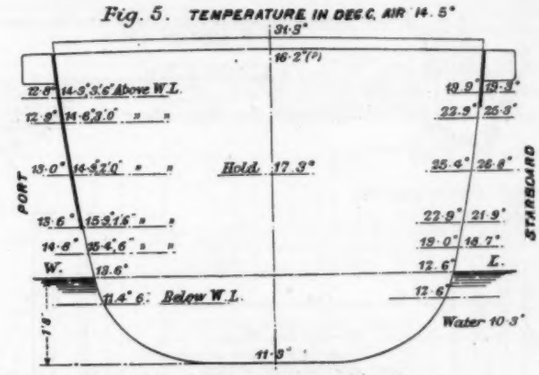
Deflection of ships is undoubtedly one of the important problems connected with the structural strength of ships and its actual measurement as well as theoretical investigations thereon are reported to kindred societies from time to time.† As far as our knowledge goes, except one paper only,‡ written by F. S. Smith of the United States Navy, the papers deal with the deflection caused by loading. In the paper just mentioned, it was reported that in the Neptune, an American collier (520 ft. by 65 ft. by 27 ft. 7½ in. draught) maximum increase of hog of 1 in. was observed on a rise of temperature of 7 deg. F. (temperature of air ?). If such an enormous amount of deflection caused by temperature difference is really possible, all the information with regard to deflection of ships so far obtained—especially the deflection after launching, an operation in which temperature distribution is likely to be totally upset—will perhaps be of no value.

The object of the present paper is to see mathematically to what extent a ship may experience deflection under an assumed mode of temperature distribution. Evidently the temperature of a ship will generally be distributed in a very complicated manner (see the end of this paper), and consequently the resulting deflection will not permit of being attacked mathematically. As a preliminary investigation, we attempt here to find only the qualitative value of the deflection, with which actual observation should be compared. Throughout this paper the following nomenclature is used (refer to Figs. 1 to 3):









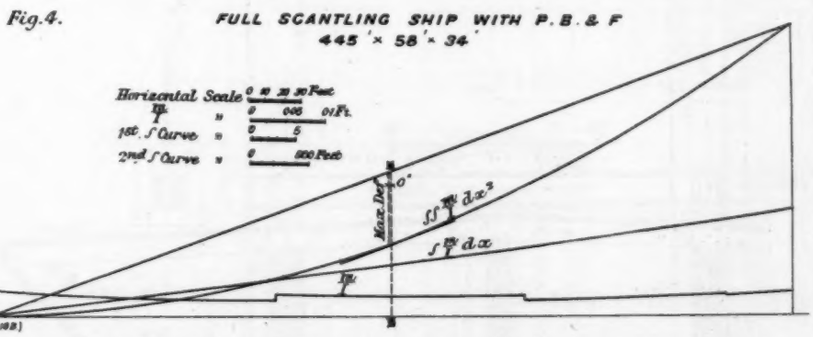


Fig. 4.
FULL SCANTLING SHIP WITH P.B. & F
445 × 58 × 34
Horizontal Scale 0 10 20 30 Feet
" 0 005 01 Ft.
1st. I Curve " 0 5
2nd. I Curve " 0 500 Feet
Max. Def.
0"
(49198)

* Paper read before the Japanese Institute of Naval Architects on April 10.

† Read and Stanbury, "On the Relation between Stress and Strain in the Structure of Vessels," I.N.A., 1894. Siemann, "Elastische Formänderung des Schiffskörper," Schiffbau, 1910. Cornbrooks, "Data on Hog and Sag of Merchant Vessels," Am. S.N.A.M.E., 1915.

‡ Smith, "Change of Shape of Recent Colliers," Am. S.N.A.M.E., 1913.

L = length of ship.
Δx = small portion of the length.
δx = uniform elongation of Δx.
$\delta \xi$ = elongation of the top of the structure due to pure bending of Δx.
Y = distance of the top of a section from its neutral axis.
Y' = distance of the bottom of a section from its neutral axis.
y = distance of a point in a section from its neutral axis.
z = amount of hog (or sag).
a = sectional area of a section.
da = infinitesimal sectional area.
$\delta \theta$ = angle through which one end section of Δx is turned relative to the other.
I = moment of inertia of a section about its neutral axis.
h = distance between water line and neutral axis.
E = stretch modulus of steel.
k = coefficient of thermal expansion of steel.
t = temperature.

Now if a ship is heated by the sun or other agent, the heat will be conducted through the hull to the sea water. When the flow of heat becomes steady, a definite distribution of temperature will be attained in the ship.

Let us suppose, for the sake of simplicity, the distribution in a section is the same at both sides of the ship and put

$$t = f(y)$$

In consequence of such a non-uniform distribution of temperature the ship will be subjected to change of its shape which may most likely be analysed into a pure elongation and a pure bending. As these deformations are caused by internal strain, not by an external force, stresses in the ship will be so distributed that the resultant force of the stresses in every section of the ship is in equilibrium in itself.

From the condition that the resultant force of the stresses in the section AB (see Fig. 1) vanishes, we have

$$\int \frac{E}{\Delta x} (\delta x - k f(y) \Delta x) \, da = 0 \quad . \quad . \quad (1)$$

Similarly, as the resultant couple of the stresses must also become zero, we have

$$\int \frac{E}{\Delta x} \left(\frac{\delta \xi}{Y} y - k f(y) \Delta x \right) y \, da = 0 \quad . \quad (2)$$

Of these two equations, the former has no importance in the present problem. From the latter we obtain

$$\frac{\delta \xi}{Y \Delta x} I = k \int f(y) \, y \, da$$

Now if we put $\int f(y) \, y \, da = M$ and make Δx indefinitely small, this equation is transformed into

$$\frac{d\xi}{Y dx} = \frac{d\theta}{dx} = \frac{d^2 z}{dx^2} = k \frac{M}{I}$$

where z is the amount of hog as already described. As is well known, the integral of this differential equation, which gives the deflection of the ship, takes the form,

$$z = k \int_0^x \int_0^x \frac{M}{I} \, dx^2 - \frac{kx}{L} \int_0^L \int_0^x \frac{M}{I} \, dx^2 \quad . \quad (3)$$

under the condition that there is no deflection at extreme ends, viz., when $x = 0$ or L, $z = 0$.

Thus, if we know the value of $f(y)$, the distribution of temperature at every section of a ship, we can find the amount of the deflection by the equation (3). The distribution of temperature, in actual cases, will depend upon various circumstances, such as the direction of the sun, the position of shadow cast by shelter, the extent of non-conductive covering, and heat of engine and boiler space. However, it will suffice our present purpose if we assume a simple mode of distribution of temperature, which may not be far from actual occurrence.

(1) If temperature is so distributed throughout a ship that it changes linearly with height and attains extreme value at the top and bottom:

Distribution of such a nature may occur in a shallow-draught boat when she is heated by the sun from right above. In this case we may assume

$$t = f(y) = \tau y + t_0$$

in which τ is temperature gradient per *unit* height and t_0 temperature at neutral axis. Then

$$M = \int_{-Y'}^{Y} f(y) \, y \, da = \int_{-Y'}^{Y} (\tau y + t_0) \, y \, da = \tau \int_{-Y'}^{Y} y^2 \, da = \tau I.$$

As it is assumed that the distribution of temperature is the same throughout the ship, we have from (3),

$$z = k \int_0^x \int_0^x \tau \, dx^2 - \frac{kx}{L} \int_0^L \int_0^x \tau \, dx^2 = \frac{k\tau}{2} x(x - L)$$

The amount of hog is evidently a maximum at $x = \frac{L}{2}$, *i.e.*, at midship, and it is

$$z = \frac{L^2}{8} k \tau$$

in which $k = 0.000012$ deg. C.

Therefore, when the temperature gradient is 1 deg. C. per foot,

$$z \text{ in inches} = 1.25 \times 10^{-1} \times L^2.$$

A few examples are here shown :—

Length of ship.	Maximum Deflection for a Temperature Gradient of 1 deg. Cent. per 1 Ft.
580 ft.	4.20 in.
445 ,,	2.48 ,,
370 ,,	1.71 ,,

(2) The parts above and below the water-line are at different, but uniform, temperatures.

Temperature distribution of such a nature may occur in a ship at night or on a cloudy day, when the upper part assumes the temperature of the air and the lower part that of the sea water.

Now let t_1 be the temperature of the part above the water line and t_2 that of the part below the same. Then,

y = from h to Y $f(y) = t_1$
y = from − Y' to h $f(y) = t_2$

in which h is the distance between the neutral axis and the water-line. In this case,

$$\int f(y) \, y \, da = \int_{-Y'}^{h} t_2 \, y \, da + \int_{h}^{Y} t_1 \, y \, da = t_2 \int_{-Y'}^{h} y \, da + (t_1 - t_2) \int_{h}^{Y} y \, da + t_2 \int_{h}^{Y} y \, da = t_2 \int_{-Y'}^{Y} y \, da + (t_1 - t_2) \int_{h}^{Y} y \, da = t_2 m$$

where $t = t_1 - t_2$, the temperature difference, and

$$m = \int_h^Y y\,d\,a$$

the moment of the sectional area above the water-line with respect to the neutral axis.

Therefore, under the assumption that one and the same temperature distribution exists throughout the ship, we have from (3),

$$z = kt\left[\int_0^x\int_0^x \frac{m}{I}\,dx^2 - \frac{x}{L}\int_0^L\int_0^x \frac{m}{I}\,dx^2\right]$$

This integration has been performed graphically in a well-known manner for three different ships (one of the graphical integrations is shown in Fig. 4 as a sample) and the results obtained are shown in the following table :—

Type of Ship.	Dimensions.	Draught.	Maximum Deflection due to a Temperature Difference of 1 deg. C.	Position where Maximum Deflection Occurs.
	Ft.	Ft. In.	In.	Ft. In.
Shelter deck with forecastle ...	580×68×46 (to S.D.)	31 10	0.153	13 0 abaft
Full scantling with p. b. and f.	445×58×34	26 3	0.092	1 0 ,,
Spar deck with p. and partial shelter deck ...	370×47×30 (to S.D.)	21 6	0.087	3 9 ,,

Putting aside the enormous values derived from the assumption (1), we can see from this table that if a temperature difference of, say, 10 deg. C., which is not improbable, exists between the parts above and below the water-line, we might expect the occurrence of a maximum deflection of somewhere about 1 in. in a medium-sized boat. This amount is evidently comparable with the extent of deflection which is generally observed due to loading or after launching. Therefore it seems that in measuring deflection of a ship—especially in the case of launching—it would be well, if possible, to measure the temperature of hull and its surroundings; unfortunately this is a matter of practical impossibility when she is irregularly heated by the sun.

In order to see how temperature is distributed in an actual ship, we measured temperature of a barge at various spots along the line of a frame by means of a thermo-electric junction. The observed distribution is shown in Fig. 5. As the diagram shows, temperature of this ship had a mode of distribution intermediate between the assumptions (1) and (2). However, we could neither measure the distribution of temperature throughout the ship nor the actual deflection that occurred. Therefore we must hesitate to draw conclusions from such an incomplete observation.

Throughout this paper we are only theorising. Unfortunately we have not often the chance of making actual measurement in a ship and cannot say to what extent our investigation holds good in actual cases. We should be much gratified if somebody who is interested in this problem and is daily occupied with ships would test the validity of our results by making further experiments along this line.

In the discussion Dr. F. P. Purvis pointed out that the method used by the authors is capable of further application, viz., to the calculation of the induced stresses brought about by the non-uniform heating of the structure. Each part, from its position, is free to take up part only of the expansion or contraction due to temperature; in so far as it cannot respond to the temperature a stress remains, compressive for increase, tensile for decrease. The value of this stress is easily derived from the expressions given in the paper. Taking compression positive :—

$$\text{Internal stress} = E\left\{k\,.\,f(y) - \frac{\delta x}{\Delta x} - \frac{\delta \xi}{\Delta x}\right\}$$

If we apply this value to case (2), and take :—

B = sectional area above water, at temperature t_1
A–B = ,, ,, below ,, t_2
m = moment of area B about neutral axis
$-m$ = ,, ,, A–B ,, ,,

then from equation (1) :—

$$\frac{\delta x}{\Delta x} = k\,.\,\frac{B\,.\,t_1 + (A-B)\,t_2}{A}$$

and, from equation (2) :—

$$\frac{\delta \xi}{\Delta x} = k\,.\,Y\,\frac{\int .\,f(y)\,y\,d\,a}{\int .\,y^2\,d\,a} = k\,\frac{Y}{I}\,(m\,t_1 - m\,t_2)$$
$$= k\,\frac{Y}{I}\,.\,m\,(t_1 - t_2);$$

also, $k\,.\,f(y) = k\,.\,t_1$ for the portion above water
$= k\,.\,t_2$,, ,, below ,,

Hence, above water :—

$$\text{Internal stress} = k\,.\,E\,(t_1 - t_2)\left\{\frac{A-B}{A} - \frac{Y\,.\,m}{I}\right\}$$

and below water :—

$$\text{Internal stress} = k\,.\,E\,(t_1 - t_2)\left\{-\frac{B}{A} - \frac{Y\,.\,m}{I}\right\}$$

Taking temperatures such that $t_1 - t_2 = 10$ deg. Cent.; then for any of the three ships treated, maximum stress works out about 1 ton per square in. Whether stresses of this nature could ever become of serious importance (when added to other stresses) is at least worthy of consideration.

DESIGN OF A RAILWAY PONTOON BRIDGE.*

By H. J. HANSEN, M.W.S.E.

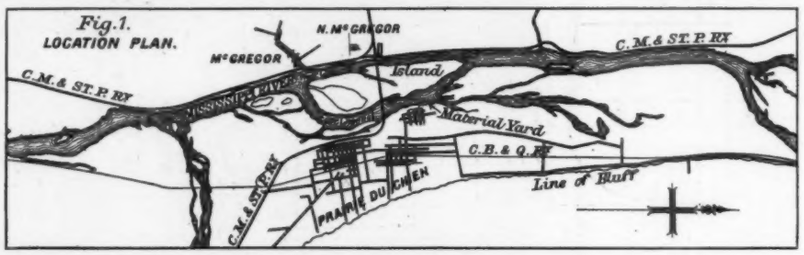
THE Prairie du Chien Division of the Chicago, Milwaukee and St. Paul Railway Company crosses the Mississippi River between Prairie du Chien, Wis., and North McGregor, Ia. (Fig. 1). About a mile and a half north of the railway crossing the river is divided into two navigable channels by an interjacent island, as shown in Fig. 1. The total length of each of the structures bridging these channels is about 2,000 ft. The total distance between the North McGregor shore and the Prairie du Chien shore is about 6,000 ft.

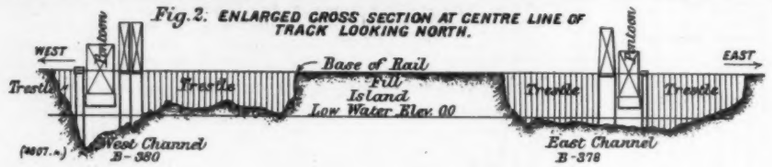
The earliest history of the bridges carrying the railroad track across these channels is not known to the writer, but records show that as early as 1857 the Chicago, Milwaukee and St. Paul Railway Company contemplated bridging these two channels, and several designers submitted plans and bids for combination iron and timber structures. However, due to the long draw opening required by the Government on account of logging, none of these plans was carried out, and the then prevailing system of ferrying the railway cars across the river on scows was continued until Mr. John Lawler, at that time freight agent at Prairie du Chien, conceived the idea of the present style of pontoon. In 1874 the first bridge of this type was constructed at this point. It consisted of ordinary pile trestle except the navigable portion of each channel, which was spanned by pontoon draws. The *Engineering News* of June 30, 1883, gives an extract of a paper on this bridge read by Mr. Lawler before an engineering convention at St. Paul.

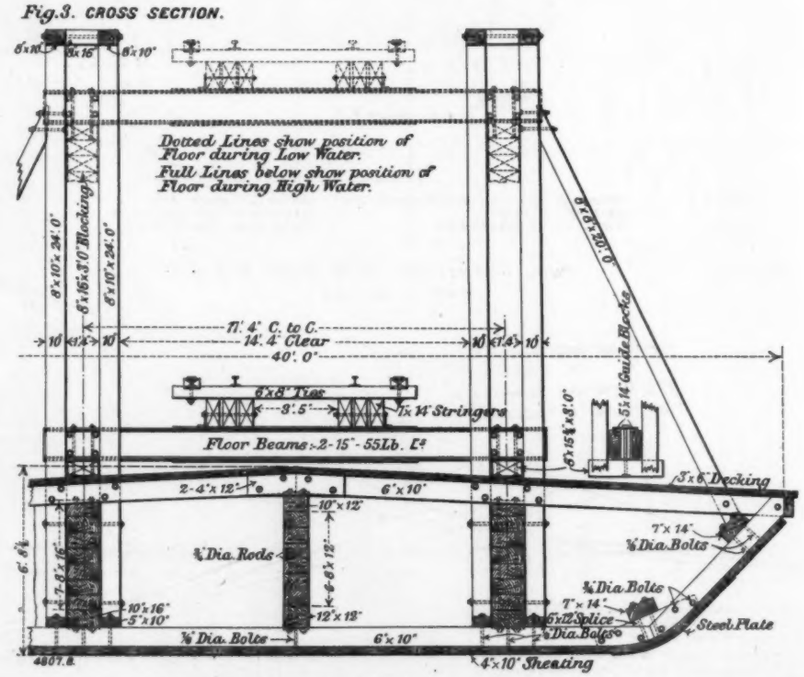
The present bridge across the east channel consists of a 209-ft. 4-in. pontoon flanked by a girder span on the east end and a truss span on the west end, the remaining portion of the track across this channel being carried on pile trestle. The pontoon was renewed in 1914, at which time the United States Government allowed a reduction in the clear opening required, from 350 ft. to 160 ft. In addition to the main draw opening, the space under the flanking spans provided a passage for small boats, on account of which the pontoon would otherwise have to be opened (Fig. 2).

The present bridge across the west channel, built in 1900, is composed of a 405-ft. pontoon flanked at each end by a 100-ft. Howe truss span, the remainder of the structure being pile trestle. This pontoon, a cross-section and part longitudinal elevation of which is shown in Figs. 3 and 4, consists of a scow 405 ft. long, 41 ft. wide at deck level, 36 ft. wide at the bottom and 6 ft. deep. Three longitudinal bulkheads, consisting of 8-in. by 16-in. and 8-in. by 12-in. timbers bolted together, extend the entire length of the pontoon, the shear between these timbers being transmitted by 2-in. diameter tree-nails. The top and bottom joists are 6-in. by 10-in. timber and the sheathing 3-in. by 10-in. planks. The floor system consists of shallow floor beams supporting two lines of timber stringers. The pontoon is approached from each end on a 30-ft. girder span, hinged at the end, resting on the pontoon so as to adjust itself to slight variations between the elevation of base of rail on the pontoon and the approach trestle. When the pontoon is opened, the abutment end of the hinge girders are supported on blocking piled up from the deck of the pontoon and so adjusted that the girders will slide off and on to the abutment bearings.

The floor beams are supported at each end on blocking piled from the deck between vertical guides. These blocks are about 8 in. thick, and the elevation of the track is adjusted by varying the number of blocks in accordance with the water level; hydraulic jacks of about 15 tons capacity being employed in raising or lowering the floor beams to adjust the track to the proper level, and one floor beam only being moved at a time. The maximum







* Paper read before the Western Society of Engineers, U.S.A.

change of track level in one movement is one block, or about 8 in.

A separate scow is provided for carrying the swinging machinery. This scow, which is 60 ft. long, 30 ft. wide and 6 ft. deep, also provides storage for about 40 tons of coal. The pull is transmitted from this scow to the pontoon by means of two struts or links, pin-connected to both the scow and the pontoon, to allow a certain amount of relative motion. One of these links connects the boats in a transverse direction, and the second in a longitudinal direction.

The pontoon is swung by means of a chain having its ends fastened to piles in the river bottom at suitable points and passing over the pontoon and machinery scow with a turn-around and ribbed drum which is driven by a 70-h.p. steam engine.

To line up the rails of the draw and the approach, the hinge end is provided with a V-shaped catch placed centrally between the rails on the hinge span directly below the base of rail. This catch engages a socket on the approach as shown in Fig. 5. The rails are lap-spliced and held in place by means of castings marked "R 2" in the figure. The rails at the lock end also are lap-spliced, but not clamped as at the hinge end. For a distance of 15 to 18 ft. the rails on the approach are not spiked to the ties, and at the free end they are connected with a spacing rod and drawn toward the projecting ends of the rails of the pontoon by a weight attached to the rails by a chain passing over a pulley located at one side of the track, as shown in Fig. 6. This weight is about 300 lb. The rails on the pontoon are bolted to the floor beams, so they will not creep either way. At the free end the pontoon is locked into its closed position by a T-shaped latch connected to the deck of the pontoon. The latch is passed between two vertical timbers or guides with the T in a vertical position and turned to a horizontal position behind the guides.

This bridge is swung open about 1,000 times during a season, which is equal to about 4.5 openings daily, the

Fig.4. LONGITUDINAL SECTION THROUGH CENTRE.

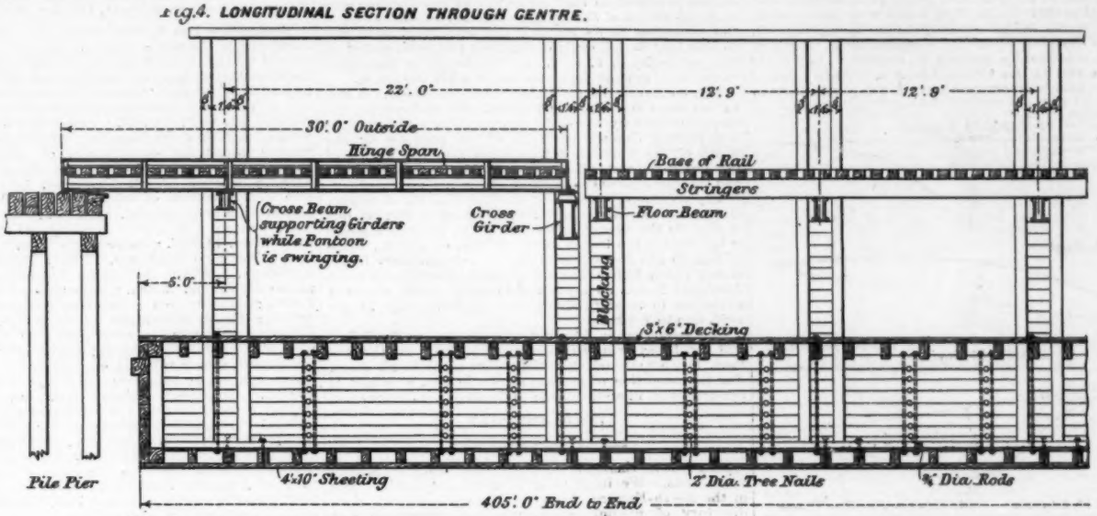


Fig.5. GENERAL PLAN OF RAIL JOINTS OLD PONTOON.

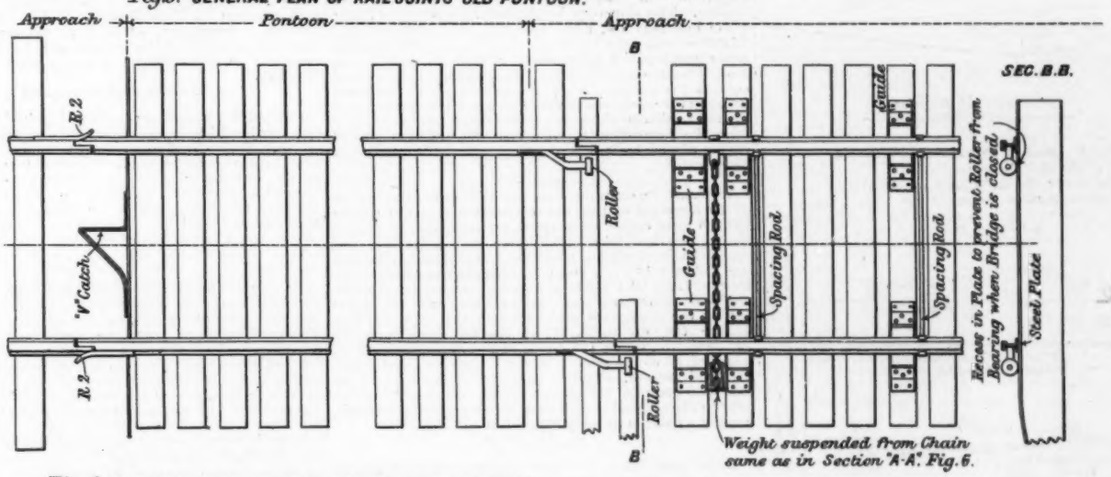
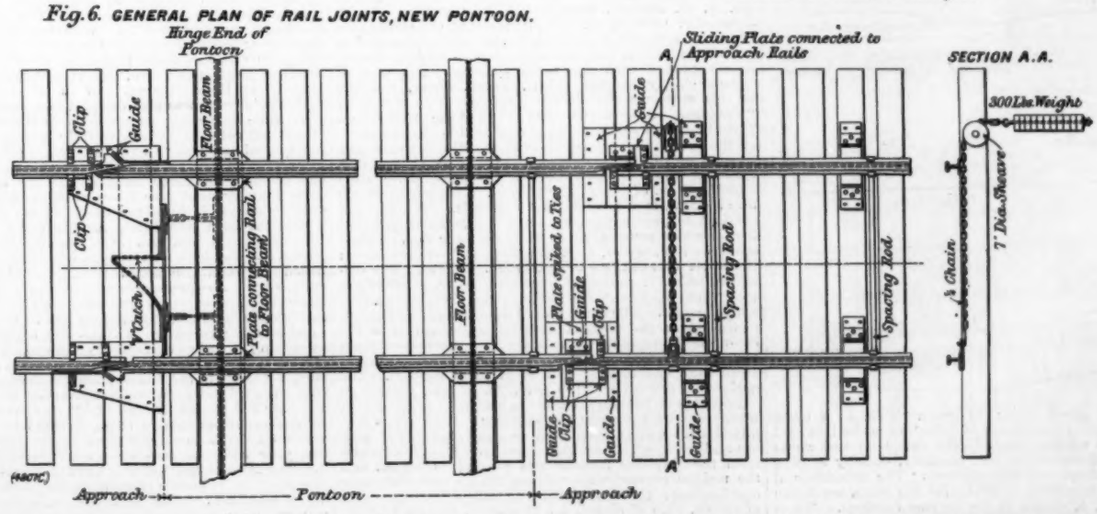


Fig.6. GENERAL PLAN OF RAIL JOINTS, NEW PONTOON.



greatest number of swings in one week being about 60. During the open season four men are required to operate the bridge, while during the closed season only three men are employed. An average of 11 tons of soft coal is consumed per month in operating the bridge and for heating purposes.

These pontoon bridges have given good service, with the exception that during high water with heavy wind storms excessive rolling of the pontoon is experienced, sometimes delaying trains for a considerable length of time and occasionally making it necessary to detour passengers via the La Crosse Division. Their term of service has also been rather short, it being necessary to

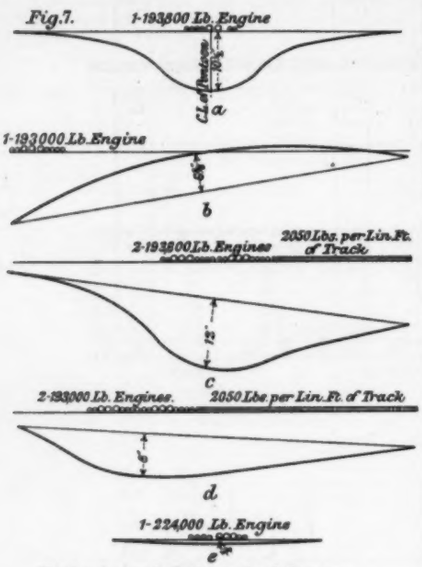


Fig.7. a, b, c and d shows the deflections of the Old Pontoon.
Fig.7. e shows the deflection of the New East Channel Pontoon.

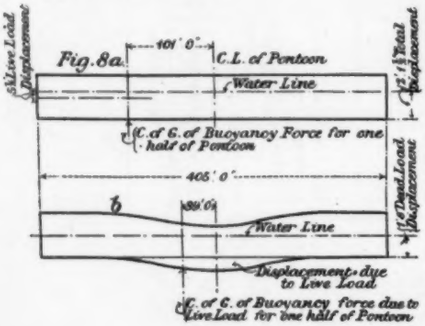
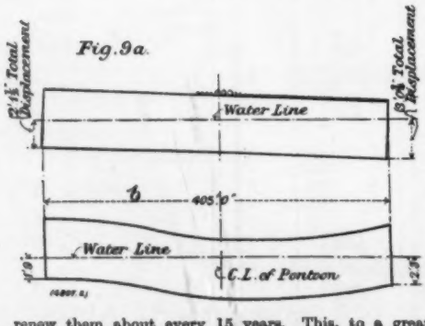


Fig.8a.
101' 0"
C.L. of Pontoon
Water Line
C. of G. of Buoyancy Force for one half of Pontoon
405' 0"
99' 0"
Water Line
Displacement due to Live Load
C. of G. of Buoyancy force due to Live Load for one half of Pontoon



renew them about every 15 years. This, to a great extent, is due to the excessive deflection under live load which opens up the joints in the sheathing and works out the caulking strips and caulking, thereby causing excessive leakage and deterioration. The deflections of this bridge, after being in service for five years, are shown in Fig. 7 (*a*, *b*, *c* and *d*) for various loadings. These deflections are from actual measurements in the field and show clearly the great lack of stiffness.

On account of this heavy deflection and also on account of the heavier loading required, the new pontoons are stiffened by four longitudinal trusses, which eliminate this excessive deflection. The actual measured deflection of the new Prairie du Chien pontoon shown in Fig. 7*e* hardly exceeds ¼ in. to ⅜ in. for any position of the load, and there can be no doubt that the trussing of these bridges will greatly increase their term of service and reduce the cost of maintaining them.

The bending stresses in these pontoons, however, are reduced very materially on account of their flexibility. This is clearly shown in Fig. 8 (*a* and *b*). A 97-ton engine is placed so that its centre of gravity coincides with the centre of the bridge, assuming the deflection of the structure to be normal, the buoyancy force due to this load is uniformly distributed and represented by the rectangle, *a*, *b*, *c*, *d*, in Fig. 8*a*. The maximum moment is found at the centre and is 8,346,000 ft.-lb.

Fig. 8*b* shows the deflection curve from Fig. 7*a* due to the same loading as in Fig. 8*a*. By multiplying the area, bounded by the deflection curve and the straight line passing through the ends of the pontoon by the width of the pontoon, it was found that the weight of this volume of water is equal to the live load, 194,000 lb., and that the ends of the pontoon suffered no displacement.

The volume of water displaced in Fig. 8*b*, of course, is equal to the volume of water displaced in Fig. 8*a*, but in Fig. 8*a* the average lever-arm of the buoyancy forces is one-fourth the length of the bridge, or 101 ft., while in Fig. 8*b* the average lever-arm of the buoyancy forces is only about 39 ft. The actual moment was found to be 2,463,000 ft.-lb., as against 8,346,000, which shows a reduction in bending stresses of approximately 70 per cent. due to flexibility.

The reduction in bending stresses due to flexibility will not be as great as this for all positions of the live load, but a material reduction takes place in all cases. For the condition of loading shown in Fig. 9 (*a* and *b*) the reduction in moment due to flexibility is 50 per cent.

(To be continued.)

THE NORTH-EASTERN RAILWAY DIRECTORY OF MANUFACTURERS.—We have received from the York offices of the North-Eastern Railway Company a copy of their directory of manufacturers, wholesale importers and exporters who reside in the districts served by their system. The directory is divided into sections under trade headings and town headings, and contains over 36,000 entries split up under more than 1,200 separate trade headings. A feature of the book is a map of the North-Eastern Railway system, showing in distinctive colours the principal natural products of the different districts it serves, and the wide range of Continental and overseas sailings which in normal times are maintained from the North-East Coast ports. No less than 15,000 copies of the book have been prepared for gratuitous distribution.

WILLIAM BEARDMORE AND CO., LIMITED.—The report of the directors of this company states that the profits for the year ended with December last, after providing for depreciation, debenture interest, and all expenses and contingencies (including provision for excess profit duties), are 232,199*l.* 11*s.* 7*d.*, and this with the amount brought forward from 1914 (193,089*l.* 3*s.* 5*d.*) makes the total at credit of profit and loss account 425,288*l.* 15*s.* After paying the preference dividend of 6 per cent. (free of income tax up to 1*s.* 2*d* in the £), there remained 347,288*l.* 15*s.*, which the directors recommend should be disposed of as follows:—Placing to special preference dividend reserve, 50,000*l.*; payment of dividend at the rate of 6 per cent. per annum on the ordinary shares for year to December 31, 1915 (free of income tax), 102,000*l.*, leaving a balance to carry forward of 195,288*l.* 15*s.*

ORES FROM COBALT, ONTARIO.—From a compilation by Mr. R. W. Bridges, published in the *Canadian Mining Journal* of January 15, 1916, we see that the production of cobalt and nickel at Cobalt is still being expressed in pounds and not in tons, whilst silver is entered in ounces, in accordance with the usual practice. The ores of Cobalt chiefly contain cobalt, nickel, silver, arsenic; in this sequence the chemical symbols give the word "Coniagas," which is the name of one of the great works. The absence of sulphur and also of lead is characteristic of the ores. In the period 1905 to 1913 the ores and concentrates from the district yielded at the Copper Cliff plant of the Canadian Copper Company more than 40,000,000 oz. of silver, 2,200,000 lb. of cobalt, 1,500,000 lb. of nickel, and 4,500,000 lb. of arsenic. The ore was crushed to pass a 30-mesh sieve and smelted in blast-furnaces of a capacity of 25 or 30 tons per day, to yield silver bullion, speiss, slag, flue dust and crude arsenic; the latter was purified by subliming. The slag was discarded unless it contained more than 10 oz. of silver per ton, when it was recharged into the furnace together with the dust. The silver gained represented 75 per cent. of the total; the fineness of 860 could be raised to 994 in oil-fired cupelling furnaces. The speiss contained about 25 per cent. of cobalt, 15 of nickel, 31 of arsenic, 16 of iron, and further 1.48 oz. of silver per ton. The speiss was ground with 20 per cent. of salt, roasted in Edwards reverberatory furnaces, and then leached with water and with sodium thiosulphate; the residue was mixed with quartz remelted, and the slag mixed with ore and returned to the blast-furnace. The green speiss from the Edwards furnace was leached as before, and the residue roasted with sodium nitrate and carbonate and leached; the final residue contained 30.7 per cent. of cobalt, 28.5 of nickel, 1.1 of arsenic, besides 34.6 oz. of silver per ton, and was shipped to Germany. The extract obtained by leaching gave copper (by treating with scrap iron) and nickel and cobalt (which were precipitated together by caustic potash) in the first instance. There are still difficulties about the separation of the two metals; but considerable progress has been made, and we have referred on other occasions to the great advantages which cobalt-plating offers.

COLONIAL ENGINEERING PROJECTS.

WE give below a few data on several Colonial engineering projects, taken from the *Board of Trade Journal*. Further information on these projects can be obtained from the Commercial Intelligence Branch, Board of Trade, 73, Basinghall-street, London, E.C.

Australia.—The Sydney Office of H.M. Trade Commissioner in Australia reports that the estimates submitted by the Commonwealth Treasurer to the House of Representatives include, *inter alia*, the following proposed expenditure for new works, additions, &c., to be carried out in Victoria:—Meteorological Bureau, 6,000*l.*; Fort Napean sea wall, 10,498*l.*; site, buildings, engineering works, machinery and plant for cordite factories, 43,000*l.*; reserve stores for manufacture of cordite, 49,000*l.*; Victoria Barracks, 11,000*l.*; Geelong Drill Room, 3,000*l.*; wooden launch (Customs), 4,800*l.*; construction and extension of telegraph lines, telephone lines, instruments and material, 117,500*l.*; Melbourne parcels post, sorting and stores building, 95,605*l.*; Bendigo Post Office, 14,270*l.*; other post offices, 26,000*l.*; Richmond Telephone Exchange, 6,000*l.*; Malvern Telephone Exchange, 5,500*l.*; Melbourne (Lonsdale-street) Telephone Exchange, 3,000*l.*; other telephone exchanges, 9,500*l.*; heating and ventilating telephone exchanges, 4,000*l.*; South Melbourne motor garage, 6,000*l.* The following estimates for works elsewhere than in Victoria were also submitted:—Flying school (new material and equipment, motor vehicles, engines and tools), 14,000*l.*; three lighthouse steamers, 20,000*l.*; two lightships, 10,000*l.* The Sydney Office of H.M. Trade Commissioner further reports that in the estimates presented to the Federal Parliament by the Treasurer provision is made for the expenditure of 47,567,026*l.* out of loans during the current financial year. The following items are included:—Constructional work on the railway from Kalgoorlie to Port Augusta, 1,500,000*l.*; construction of railway from Pine Creek to Katherine River, 180,000*l.*; purchase of land and erection of buildings in London, 120,000*l.*; construction of railway from Port Moresby to Astrolabe, and wharves at Port Moresby and Samarai (Papua), 20,000*l.*; machinery, erection of machine shops and wharf construction at Cockatoo Island, N.S.W., 132,000*l.*; construction of conduits and laying wires underground, 300,000*l.*

CANADIAN RAILWAYS.—Five hundred steel-framed box cars have been ordered for the Canadian Government railways from the Eastern Car Company, and 500 from the Canada Car Company. These orders are regarded as the forerunner of larger contracts to follow. The Canadian Northern Railway Company proposes to expedite the linking up of its lines between Toronto, Montreal and Quebec. This will involve the completion of the Mount Royal Tunnel terminal scheme.

PETROL.—The Shell Transport and Trading Company, Limited, has such a world-wide connection that its opinions upon trade subjects are of exceptional value. The production of petrol in the United States now amounts to 4,000,000 tons per annum, and Sir Marcus Samuel states that there was not at any time last year any difficulty in obtaining petrol for the British market. It was, in fact, purely a question of price coupled with the possibility of obtaining transport. The war created, however, a demand for petrol of such an unprecedented and unforeseen character that it falsified all calculations, and the Shell Transport and Trading Company decided to assist the Government by assuring it of a constant supply of petrol at moderate prices. The greater portion of the company's fleet last year was engaged either directly or indirectly in the Government service; and owing to this fact some promising ventures which the directors had entered into, believing that it would have tonnage at their disposal, had to be neglected. The company's trade was also crippled last year by the fact that while chartering its steamers to the Admiralty at Blue-Book rates, it had to give fully four times the price for neutral tonnage to meet its own requirements, and even on these terms it has not always been able to obtain the tonnage necessary to maintain its business. As from January next year all users of Shell spirit will be able to obtain it from the Shell Marketing Company, which has been established for the purpose of selling the company's products in Great Britain—not only petrol, but also kerosene. Users will thus not be compelled to obtain supplies from the German-owned companies. The production of petroleum in the Dutch Indies last year was on a satisfactory scale. From Kotei and largely from Sumatra the oil has to be transmitted to consuming centres. In Java the company is able to obtain the full advantage of geographical position, as the oil is all sold locally. The magnitude of the company's interest in the Dutch Indies is shown by the fact that the staff employed there comprised at the close of last year 816 Europeans and 17,553 natives and Chinese. Extensions of storage in these districts amounted last year to 735,500 tons. Satisfactory progress was made last year with the development of Sarawak, and the directors are satisfied that they have a valuable field there. A refinery is in course of construction and a new pipe line is being laid, so that the largest ocean-going steamers will be able to load there at all times. Egypt, in which the Shell Company has a large stake, continues a disappointing region, but the associated company in Egypt has been able to render signal service to the Egyptian Government. In Trinidad, in which the Shell Company has some small interests, commercial success is not yet in sight, although the company's shipments to the Admiralty and others have been larger than those of any other British undertaking.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

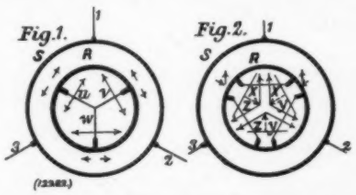
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

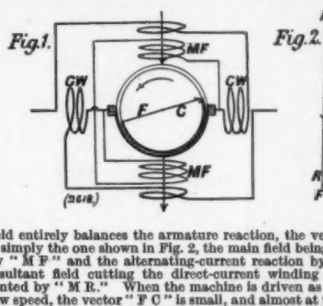
ELECTRICAL APPARATUS.

12,282/14. A. Heyland, Brussels, Belgium. Polyphase Commutator Machines. (5 *Figs.*) June 14, 1913.—This invention relates to polyphase commutator dynamos and motors. Fig. 1 shows the bipolar diagram of a three-phase commutator with the three leads 1, 2, 3 and tri-axial short-circuit of brushes on axes *u*, *v*, *w*. If the short-circuit were mono-axial, as is the case with single-phase motors, the short-circuit would neutralise the field in the short-circuit axis when the motor is stopped, and not in the axis perpendicular thereto. With these tri-axial short-circuits, however, there can be no appreciable armature field when the motor is at rest. Even assuming the motor to be so wound that the axes of the stator coils, as in the position shown, do not coincide with the brushes, the field will be annulled, with the brushes in any position, by the short-circuit currents over the brushes. In this case the flux in the rotor would have to have the direction shown by the arrows inside the rotor, forming a triangle, and would create, in the two halves of the short circuit between each pair of brushes, tensions of different phases, indicated by the small arrows shown outside the rotor. The armature has the same action as the short-circuit armature of an induction motor, and an armature-field cannot occur when stationary. According to this invention, an effect similar to that in single-phase repulsion motors is obtained by using a rotor having a chord winding with brushes on a commutator, short-circuited in different axes, accord-



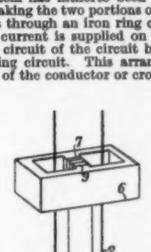
ing to the number of phases, or connected by circuits of low tension, said brushes bearing on parts of the commutator whose angular distance apart is greater or less than the angle between the axes of the several phases of the stator winding. Fig. 2 shows an arrangement of the brushes to this end, the brushes being connected in three pairs in the *x*, *y* and *z* axes, the distance between the brushes being somewhat less than the angle between the phases of the stator. In this case again, assuming there to be a three-phase stator winding with short coils, the field produced by the stator would be represented by the vectors arranged in a triangle. In this case, however, it will be seen that the currents induced in the short-circuits *x*, *y*, *z* must produce, at the parts not spanned by the three pairs of brushes, a field as indicated by the radial arrows shown in broken lines inside the rotor ring R, and this field will be imposed upon the field originally produced by the stator, so that a field as indicated by the arrows in full lines will result, in exactly the same manner as the single axial field in the single-phase repulsion motor. The full-line arrows outside the rotor circle represent the mono-axial resultant field for the phase 1 only, and the broken-line arrows represent the two adjacent correcting fields. In the zero position shown only a weak magnetising current flows between the brushes, this current just sufficing to produce the correcting field indicated by the arrows shown in broken lines. (*Sealed.*)

2,618/15. Crompton and Co., Limited, and N. Pensabene, Chelmsford. Dynamo-Electric Machines. (5 *Figs.*) February 18, 1915.—This invention has reference to that class of dynamo-electric machines which, when used in conjunction with accumulators, are suitably adapted for the dual purpose of electric lighting and engine starting in all types of vehicles, boats and the like, which are driven by internal-combustion engines. The object of the invention is to provide a machine which, when running as a dynamo driven by the engine, will give an almost constant voltage over a very wide range of speed, or when running as a motor from power supplied by the accumulators will be capable of giving a powerful torque in the most efficient manner for the purpose of starting the engine. The invention consists in the use of compensating winding in a dynamo-electric machine of the type described in Specification No. 11,399, of 1914, for the purpose of allowing the brushes to be placed in the neutral position, and of using the machine as a self-regulating dynamo or as a motor having a powerful torque. The armature is, as already proposed, provided with two windings, which consist of an ordinary direct-current winding connected to a commutator in the usual way, and a superimposed distributed alternating-current winding, which, if it contains a sufficiently high resistance, may be short-circuited on itself, or otherwise may be connected through non-inductive resistances of suitable dimensions placed in series with it. This winding, which may be a squirrel-cage, may have any number of phase greater than one, and may be connected to a suitable number of slip-rings for the purpose of using independent adjustable resistances which would be connected across them. The main field, the axis of which is at 90 deg. or thereabouts to the line of brushes, consists of a distributed shunt-winding, with or without a few series turns. The action of the machine, as above described, when operating as a dynamo would be similar to that of the self-regulating dynamo as described in the prior specification above referred to, in which advantage was taken of an alternating-current reaction to reduce the flux cutting the armature direct-current winding as the speed increased, so that the product of the speed and flux (and in consequence the electromotive force generated) were approximately constant for large variations of speed. In the present invention the line of brushes is at 90 deg. to the main field, and an additional winding is placed at 90 deg. to the main field, which entirely or partially compensates the armature reaction. The field due to this additional winding is preferably produced by the main current, and therefore, like the armature reaction, it varies in proportion to it, but can be a simple shunt-winding. Apart from this function this compensating winding has further advantage of preventing distortion due to armature reaction, of improving the commutation, and of rendering the voltage regulation practically independent of the armature direct-current reaction. In Fig. 1 the main direct current and the auxiliary alternating-current armature-windings are represented respectively by the outer and inner circles. The main field is marked "M.F.," and the compensating winding is marked "C W." In the diagram a few turns of series winding are shown. These turns oppose the main field when the machine works as a dynamo, and help the main field when the machine works as a motor. When working as a dynamo, the current being small, the series field has very little effect; whilst running as a motor and taking considerably more current it has the effect of strengthening the main field considerably, the machine thus having the characteristics of a compound motor. Assuming that the compensating



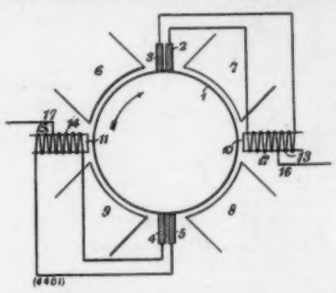
field entirely balances the armature reaction, the vector diagram is simply the one shown in Fig. 2, the main field being represented by "M F" and the alternating-current reaction by "F C," the resultant field cutting the direct-current winding being represented by "M R." When the machine is driven as a dynamo at low speed, the vector "F C" is small, and almost at 90 deg. to the main field "M F." The demagnetising effect therefore is very small. As the speed increases this reaction "F C" increases, and it opposes more and more the main field. It is an important feature of this machine that, when working as a motor, it should run at a very much lower speed than when driven by the engine as a generator, and this can be easily arranged for by having the machine unsaturated. The reason for arranging for a very low speed is to reduce the losses in the auxiliary winding, which vary almost as the square of the speed. The demagnetising effect of this winding at low speed is practically negligible owing to the fact that its reaction is almost at 90 deg. to the main field. (*Sealed.*)

4432/15. The British Thomson-Houston Company, Limited, and E. B. Wedmore, London. Circuit Protective Devices. (8 *Figs.*) March 20, 1915.—This invention relates to improved balancing transformers for the so-called "split conductor" protective system. As shown in Specification No. 4,004, of 1911, the two portions of a split conductor at each end of a feeder are associated in opposite senses with a magnetic core so that the normally equal currents produce no flux, their inductive effects being balanced and mutually neutralised. In the event of a fault on one of the portions of the conductor, the balance is upset at both ends of the feeder, and the resultant inductive effect on the magnetic core is used to cut out the defective feeder at both ends. The above-mentioned system has hitherto been usually carried into effect in practice by taking the two portions of the split conductor in opposite directions through an iron ring carrying a secondary winding, from which current is supplied on the occurrence of a fault to the tripping circuit of the circuit breaker or to a relay which closes a tripping circuit. This arrangement necessitates crossing the portions of the conductor or crossing one portion on



itself even when a bar or single turn primary winding is employed, and this crossing presents difficulties, especially on high-voltage feeders such as 100,000 volts. According to this invention, crossing the portions of the conductor is avoided and a safer construction is provided by taking the two portions of the split conductor in the same sense straight through the apertures of a three-limb shell-type core. The secondary circuit is wound on the central limb of this core. Normally the fluxes due to the equal currents in each portion of the split conductor circulate around the outside of the core, but any unbalancing due to a fault or other circumstances causes a flux to pass through the central limb. The two portions 1 and 2 of the split conductor pass in the same direction through the apertures of a figure 8 shaped core 6, on the central limb 7 of which the secondary winding 9 is located. The outer frame of the core will be always magnetised, but only if the currents are unequal will flux traverse the middle limb. 10 indicates a relay which operates to close the tripping circuit of the circuit breaker when the secondary winding of the transformer is energised owing to unbalancing of current in the two portions of the conductor. (*Sealed.*)

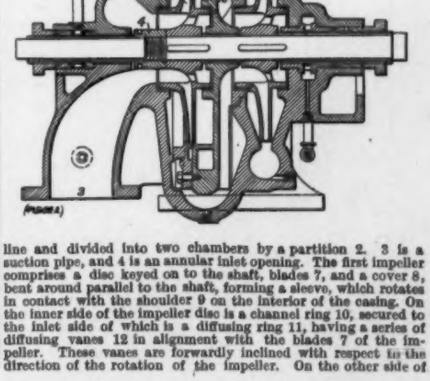
4401/15. M. Walker, Manchester. Rotary Converters. (1 *Fig.*) March 20, 1915.—This invention has for its object to provide an improved electric rotary converter in which a very large variation in voltage on the direct-current side can be readily obtained. It has already been suggested to employ for the attainment of the above object what is commonly termed a split-pole rotary converter, that is to say, a converter in which the poles are divided into a number of portions the amount and direction of the magnetic flux in which can be varied so as to alter the position of the magnetic centres of the poles in relation to the position of the brushes, and in that way to alter the voltage delivered at the direct-current brushes. With this arrangement, however, variation of the voltage over a very wide range is impracticable owing to commutation difficulties which cause excessive sparking. According to this invention, the difficulties above referred to are avoided by combining with the split poles of a rotary converter a commutating pole which is energised from a double brush in the manner described in Specification No. 27,966, of 1909. As described in this prior specification, the double brush consists of two distinct portions, and the winding of the commutating pole is connected between said portions. 1 represents a two-pole drum-wound armature and commutator of the ordinary type provided with direct-current brushes 2, 3, 4 and 5. When the brushes 2 and 3 form a compound positive brush, those marked 4 and 5 form a compound negative brush. The slip rings of the rotary converter are not shown, but are connected in the manner usual in any ordinary two-pole rotary converter. 6, 7, 8 and 9 are polar projections excited ordinarily by means of a winding connected either to the supply or to a separate exciter. When 6 and 7 are excited so as to form a south pole, 8 and 9 will be excited so as to form a north pole. In such a case with a clockwise rotation of the armature, as shown by the arrow, and with a drum winding of the ordinary kind, the compound brush 2, 3 may be positive, and the compound brush 4, 5 may be negative. The machine is provided with commutating poles 10 and 11, and the armature being of the ordinary two-pole drum type, the commutator bars which are in contact with the brushes are connected to armature conductors passing under the commutating poles. The commutating poles are provided with windings 12, 13, 14, 15, respectively connected to the compound brushes as shown and as described in the prior specification referred to, the external leads 16, 17 being connected at suitable points in the winding, and the relative number of turns in the parts of the winding 12 and 13 being so adjusted as to bring about good commutation. The current will then divide between brushes 2 and 3 and 4 and 5, so that the commutating poles will be



properly excited at all loads. If the poles 8 and 9 are of north polarity, the commutating pole 10 will also be of north polarity (the rotary converter acting as a generator on the direct-current side); and if 6 and 7 are of south polarity, 11 will also be of south polarity, and the rotary converter delivers its full voltage at the direct-current side, in what will be called for the purpose of this description the "positive" direction. When it is required to vary the direct-current voltage of the rotary converter the poles 6 and 8 are weakened and the poles 7 and 9 strengthened, then the poles 6 and 8 are reversed in polarity and weakly excited, the excitation of poles 7 and 9 being correspondingly adjusted step by step until 6 and 9 are north poles and 7 and 8 are south poles, all being the same strength. There will now be no voltage between the direct-current brushes 2, 3 and 4, 5, although there is full voltage on the alternating-current slip-rings. Poles 7 and 9 may now be weakened and poles 6 and 8 strengthened, then poles 7 and 9 are reversed and weakly excited, poles 6 and 8 being correspondingly adjusted step by step until the poles are all of the same strength, 6 and 7 being north poles and 8 and 9 south poles. The compound brush 2, 3 will now be a negative brush, and the compound brush 4, 5 positive. The voltage supplied to the direct-current leads is reversed to what will be called the "negative" direction, and the current still divides between the brushes 2, 3 and 4, 5 respectively, so as to excite the commutating poles 10 and 11 at the right polarity. It will thus be seen that the voltage delivered at the direct-current brushes can be changed so as to operate from the maximum in one direction through zero to the maximum in the other direction. (*Sealed.*)

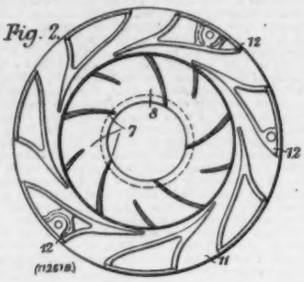
PUMPS.

17,267/15. W. J. Mellersh-Jackson, London (*A. S Cameron Steam Pump Works, New York City, New York, U.S.A.*). **Multi-Stage Centifrugal Pumps.** (3 *Figs.*) December 8, 1915.—This invention relates to multi-stage centrifugal pumps. According to this invention, the fluid from the first one or more impellers flows radially into a diffusing chamber provided with the diffusing vanes, while the fluid from the last impeller flows directly into a peripheral volute chamber provided with a tangential fluid outlet. The pump shown is a two-stage pump, comprising a casing split horizontally on the shaft



line and divided into two chambers by a partition 2. 3 is a suction pipe, and 4 is an annular inlet opening. The first impeller comprises a disc keyed on to the shaft, blades 7, and a cover 8, bent around parallel to the shaft, forming a sleeve, which rotates in contact with the shoulder 9 on the interior of the casing. On the inner side of the impeller disc is a channel ring 10, secured to the inlet side of which is a diffusing ring 11, having a series of diffusing vanes 12 in alignment with the blades 7 of the impeller. These vanes are forwardly inclined with respect to the direction of the rotation of the impeller. On the other side of

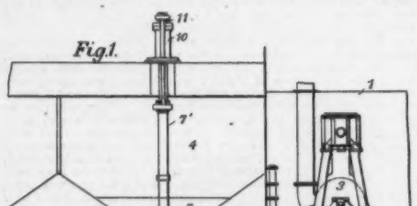
the channel ring 10 are vanes 13, which direct the fluid from the first impeller to the inlet of the next. The diffusing vanes 12 and the directing vanes 13 are near the outer edge of the channel ring 10, so that a peripheral chamber without directing vanes is provided which conveys the fluid from the diffusing

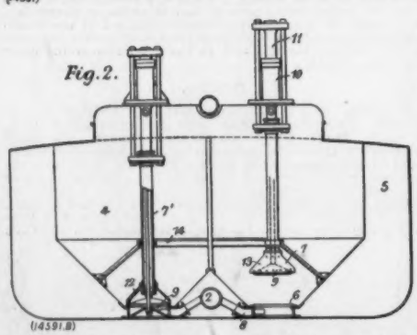


vanes 12 to the directing vanes 13. From the inner ends of the directing vanes 13 the fluid flows into the suction opening of the impeller of the last stage. There are no diffusing blades provided for this impeller, but the fluid is discharged directly into the spiral volute 20, which discharges through a tangential pipe. (*Sealed.*)

SHIPS AND NAUTICAL APPLIANCES.

14,591/15. Wm. Simons and Co., Limited, W. Brown and W. Brown, Renfrew. Hopper Dredgers. (4 *Figs.*) October 15, 1915.—This invention is applicable to suction-hopper dredgers as well as hopper dredgers of the bucket type, or combined bucket and suction dredgers. The invention consists primarily in the provision of a double valve seated on the hopper bottom and comprising a valve member adapted to control communication between the hopper and a conduit or conduits (pipe or hollow keelson) leading to a pump and a valve member normally controlling communication with the sea and adapted when open to permit the discharge of the contents of the hopper direct into the sea. The dredging vessel 1 is fitted with a conduit or conduits (suction pipe 2) preferably disposed longitudinally thereof and connected to the pump 3, the conduit 2 being adapted to be placed in communication with the hoppers 4, which are disposed in adjoining rows, one on each side of the centre line of the vessel, and enclosed between

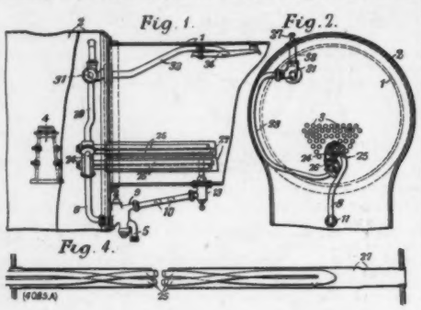


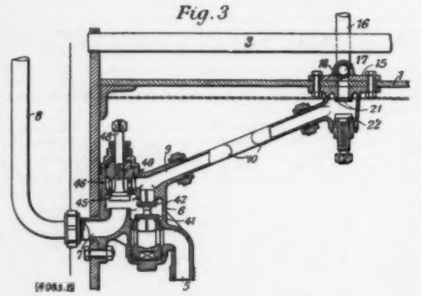


water-tight compartments 5. Each hopper 4 is provided with an outlet affording a valve seat 6, co-operating with which is a double valve, comprising an upper valve member 7 controlling communication between the hopper 4 and the conduit 2 (by way of the connection 8) and a lower valve member 9, which, when moved from its seat, permits discharge of the contents of the hopper into the sea. The valve members may be operated manually or mechanically, but are preferably operated by means of duplex hydraulic rams as shown; the ram 10 serving to lift the valve member 7, and the ram 11 serving to lift the valve member 9, it being understood that when the valve member 9 is lifted the valve member 7 may be lifted therewith. The valve stem 7¹ of the valve member 7 being hollow, serves as a conduit for pressure water, which may be discharged through ducts such as 12 and/or through a series of orifices such as 13, the object of such discharge being to loosen the material at the bottom of the hopper. It will be appreciated that on removal of the stay 14 the valves may be conveniently lifted out for repair or other purposes without the necessity for dry-docking the vessel. (*Sealed.*)

STEAM-ENGINES, BOILERS, EVAPORATORS, &c.

4085/15. G. H. Williams and E. S. Luard, London. Feed Water Heating. (7 *Figs.*) March 13, 1915.—This invention relates to feed water heating and water circulating apparatus for locomotive and other boilers. The present invention principally consists in the provision, in feed water heating and boiler water circulating apparatus, for locomotive and other boilers, of the kind in which valve devices are provided on the inlet and outlet sides of the heating means whereby the latter may be put out of communication with the boiler and the boiler fed through that part of the water circulating means connected with the bottom of the boiler, of a valve device at the water inlet side of the heating means so constructed and arranged that when operated to put the heating means out of communication with the boiler it opens in the apparatus the path for feeding the boiler through the said part of the water-circulating means, and *vice versâ*. 1 is the boiler shell. 5 is a spigot provided on a valve casing, to which spigot the supply pipe from the boiler feed pump or injector is connected, and 7 is another spigot on the same valve casing to which one end of the pipe 8 leading to the heater is connected, 9 being a third spigot connected by a pipe 10 to a spigot on a valve casing 13 secured to the bottom of the boiler 1. Within the boiler 1 a fitting 15 is mounted, to which a pipe 16 is connected, the pipe 16 extending upwardly to the level of second or third row from the bottom of the boiler tubes. The fitting 15 communicates with the interior of the valve casing 13. 22 is a valve adapted in certain circumstances to interrupt the connection between the valve-chamber 13 and the boiler. The pipe 8 at its upper end is connected to a header 24 divided into chambers, to which the heater elements 25, 26 are connected. The header 24 is connected at its outlet side to the pipe 28, which is connected to the valve casing 31, a branch from which is connected with a delivery pipe 33. The delivery pipe delivers the

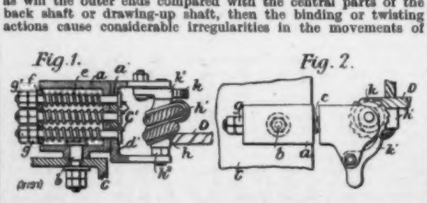




water downwardly on to a distributing plate 34, so arranged that the water is delivered at as high a point in the steam-space as is practicable. A valve seat is provided in the valve casing at the inlet to branch 32, a valve being provided with a spindle 37 and adapted to be, in certain circumstances, seated upon the valve seat. The stem 37 extends to the exterior of the smoke-box and is surrounded by a tube or sheath 38 secured in place so that the spindle 37 is operable to manipulate the valve from outside the smoke-box without affecting the vacuum obtaining therein. Referring now more particularly to Fig. 3; within the valve casing 6, three valves are provided, viz., two mitre and automatically operating circulator clack valves 41, 42, and a manually operable valve 45. The valve 41, in its seated position, closes communication between the interior of valve casing 6 and spigot 5, and valve 42 in its seated position closes one means of communication between the interior of valve casing 6 and spigot 9. The valve 45, which is provided with a threaded operating spindle 48, in its uppermost seated position shown, closes communication between the interior of the valve casing 6 and the spigot 9, and in its lowermost position, *i.e.*, seated on seat 47, closes communication with spigot 9. (*Sealed.*)

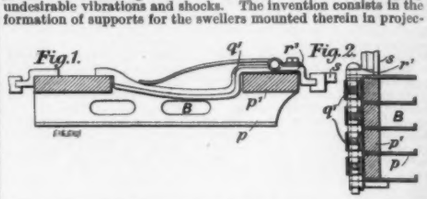
TEXTILE MACHINERY.

5137/15. J. T. Walker and J. H. Howarth, Bolton, and the Fine Cotton Spinners' and Doublers' Association, Limited, Manchester. Spinning Mules. (5 *Figs.*) April 3, 1915.—This invention relates to spinning mules. In these machines it has been found that when the carriage commences to run in or to be what is commonly termed "drawn-up" or "pulled-up," to carry out the winding of the threads upon their spindles, considerable power has to be exerted through and by the parts or mechanism which actuate same, since the whole weight of the carriage and the parts it carries have to be overcome in starting same into motion from a state of rest. For this reason, should any parts yield more than others, as will the outer ends compared with the central parts of the back shaft or drawing-up shaft, then the binding or twisting actions cause considerable irregularities in the movements of



the carriage and the driving of the spindles, with resultant defects in the yarns or threads. This is particularly the case in long mules where the torsion of the back shaft or drawing-up shaft causes the outer ends of the carriage to commence their inward movement later than those parts thereof in proximity to the headstock. The present invention consists in an improved arrangement to obviate these disadvantages, and comprises a bracket to which the drawing-up band is connected, a casing or bracket carried by the carriage, a resilient device contained within or upon the casing or bracket and a connection between the first-named bracket and the resilient device. C indicates a portion of the carriage square and D the drawing-up band. A bracket, box or casing *a* is mounted upon the carriage square C by means of a stud or bolt *b*, around which the casing or bracket *a* may swivel. This casing or bracket *a* has openings formed in its wall *a*1 through which extend the bolts *c* having heads *c*1, which bolts may be fixed to the wall *d*1 of the bracket *d* or may slide freely therethrough. Surrounding the bolts *c* are springs *e*, one end of each taking against the wall *a*1, and their other ends against a loose plate *f*, which latter may be caused to slide within the casing *a* by means of the nuts *g* in order to regulate or adjust the tension of the springs *e*. The bolts *c* are preferably prevented from turning when the nuts *g*, *g*1 are being rotated by having flat parts arranged on their heads *c*1. On the bracket *d* is mounted a scroll or its equivalent *h*, around which passes the drawing-up band D, the scroll being provided with a looped part or extension *h*1 of well-known form, through which the end of the drawing-up band D is passed, to be secured in any appropriate manner. Upon the scroll *h*, or upon the spindle *h*2 thereof is fixed a ratchet wheel, with which engages a pawl *k*1, the pawl being to prevent the return movement of the ratchet wheel *k* when same is rotated (by means of the square part *h*5 on the scroll *h*) for the purpose of tightening the drawing-up band D when same has become stretched, as will be readily understood, this device being well known as used for adjusting check-bands in spinning mules. (*Accepted March* 22, 1916.)

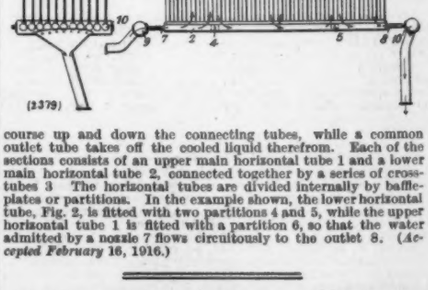
16,510/15. George Hodgson, Limited, Bradford, and G. H. Hodgson, Hitchin. Shuttle Boxes. (2 *Figs.*) February 27, 1915.—The invention relates to shuttle-boxes of the type or class known as "rising and falling" or "drop" boxes wherein the several compartments are formed by sheet-metal partitions held in position by wooden spacing-pieces, and the invention has for its object the production of parts to be used in conjunction or connection with these shuttle-boxes, of such character that the movements of the shuttles and of the picking mechanism actuating the same are prevented from setting up undesirable vibrations and shocks. The invention consists in the formation of supports for the swellers mounted therein in projec-



tions on the metal sliding parts to the rear of the wooden spacing or dividing parts. The shuttle-boxes B are, as is hereinbefore stated, of the rising and falling type, and these are formed in well-known manner by having sheet-metal partitions *p*, with spacing-pieces of wood *p*1. However, instead of fitting the pivotal pin or pins *q* for carrying the swell levers *q*1 in the shuttle-boxes to pass through the wooden spacing or dividing parts *p*1 forming the shuttle-box back, the metal sliding parts *r*, which take into grooves or over guides in the framework *s*, are arranged so that projections *r*1 extending therefrom may form supports for the pin *q*, upon which the swellers *q*1 are mounted. (*Sealed.*)

MISCELLANEOUS.

2,379/15. H. L. Short, Eastchurch. Radiators. (2 *Figs.*) February 15, 1915.—This invention refers to that type of radiator comprising a plurality of cooling sections, each consisting of an upper and a lower tube connected by tubes extending at right angles thereto. According to the present invention, all the sections are similar to one another, and each upper and lower main tube is fitted with partitions or baffle-plates, to cause liquid admitted by a common inlet tube to take a circuitous



course up and down the connecting tubes, while a common outlet tube takes off the cooled liquid therefrom. Each of the sections consists of an upper main horizontal tube 1 and a lower main horizontal tube 2, connected together by a series of cross-tubes 3. The horizontal tubes are divided internally by baffle-plates or partitions. In the example shown, the lower horizontal tube, Fig. 2, is fitted with two partitions 4 and 5, while the upper horizontal tube 1 is fitted with a partition 6, so that the water admitted by a nozzle 7 flows circuitously to the outlet 8. (*Accepted February* 16, 1916.)

IRON AND STEEL IN AUSTRALIA.—During the four weeks ended June 25 the Newcastle works of the Broken Hill Proprietary Company, Limited, had produced 8,556 tons of pig in the blast-furnaces, of which 8,223 tons had passed through the blooming and rolling mills. The coke produced at the works had been consumed in the blast-furnaces, and 75 tons of ammonium sulphate had been obtained; the coke production was discontinued. The output of iron ore at Iron Knob, in Eyre Peninsula, South Australia—not far from the smelting works of the company at Port Pirie—had amounted to 13,727 tons. The concentration plant treated 12,069 tons of ore. It will be remembered that the Broken Hill mines are situated in New South Wales, but close to the borders of South Australia, so that Port Pirie and Adelaide—both in South Australia—are the nearest ports for the mines; Iron Knob has its port at Hummocky Point.